Case Report

Preoperative Identification of a Bone–Cement Allergy in a Patient Undergoing Total Knee Arthroplasty

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Abstract: Allergy to polymethyl methacrylate bone–cement or its components is unusual. Because of the potential for an inflammatory response in an allergic patient and the possibility of pain and loosening if a cemented implant is used, it is imperative to identify patients with this allergy to modify their treatment. We report the case of an otherwise healthy 60-year-old woman who needed a total knee arthroplasty and who had an allergy to methyl methacrylate bone–cement identified preoperatively. The appropriate evaluation for a patient who is suspected to have an allergy to bone–cement or its components is reviewed. **Key words:** allergy, bone–cement, knee, arthroplasty.

Hypersensitivity reactions to the various components used in total joint arthroplasty, including metallic components and bone–cement, have been described [1–4]. Allergy to polymethyl methacrylate bone–cement or its components is unusual but has been reported in several different settings, including dentistry, orthopaedic surgery, the printing industry, and as a reaction to cosmetics [5–7]. Because of the potential for an inflammatory response in an allergic patient and the possibility of pain and loosening if a cemented implant is used, it is imperative to identify patients with this allergy to modify their treatment. We report the case of an otherwise healthy 60-year-old woman who needed a total knee arthroplasty and who had an allergy to methyl methacrylate bone–cement identified preoperatively. The appropriate evaluation of a patient who is suspected to have an allergy to bone–cement or its components is reviewed.

Case Report

A 60-year-old woman presented with a 10-year history of progressively worsening right knee pain. The patient described pain and a *giving-way* sensation of the right knee with a significant increase in severity over the past year. Treatment provided by her primary care physician included anti-inflammatory medications and hyaluronate injections, which initially were effective, but her pain and disability recurred.

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Physical examination revealed an antalgic gait with 5° varus alignment of the right knee. Tenderness was noted on patellar compression and over the medial joint line with pain at the extremes of flexion. Range of motion was 0° to 105°. There was no significant collateral or cruciate ligament laxity. Radiographic examination showed advanced degenerative arthritis with significant involvement of the medial and patellofemoral compartments. A right total knee arthroplasty was indicated.

Further history revealed that the patient had experienced an allergy to artificial acrylic-based fingernails. She explained her hands were extremely irritated and the nails were removed after a brief period. The patient also had experienced blisters in her mouth as a reaction to a temporary filling that was placed before the permanent filling. The patient's dentist diagnosed her with an allergy to methyl methacrylate. The patient reported no other known allergies to metals or to hair coloring.

To confirm the methyl methacrylate allergy, patch testing was done with a test panel of bone–cement components (Palacos Bone Cement; Biomet, Warsaw, IN). This panel included 2% and 4% weight-to-weight mixtures of the liquid monomer methyl methacrylate (also contains *N,N*-dimethyl-*p*-toluidine, hydroquinone, and chlorophyll) in petrolatum, methacrylate copolymer powder (also contains di-benzoyl peroxide, zirconium dioxide, and chlorophyll), a patch of solidified bone–cement, and a control consisting of petroleum jelly. On examination 72 hours later, erythema and induration were noted in the areas exposed to the polymerized bone–cement and to the 2% and 4% mixtures of liquid monomer methyl methacrylate. The methacrylate copolymer powder and control elicited no reaction. Because the patient reacted to the liquid methacrylate monomer and to the polymerized bone–cement, we decided the use of a cemented total knee arthroplasty was contraindicated.

The patient underwent a right total knee arthroplasty using noncemented, porous ingrowth components. Her postoperative course was uneventful, and at 2 years postoperatively, the patient was walking unlimited distances without assistive devices. Active range of flexion was 0° to 125°. She was able to do all of her activities of daily living.

Discussion

Allergy to methyl methacrylate bone–cement or one of its components should be considered a contraindication to the use of cemented implants. Haddad and Cobb et al [8] described 7 patients with a history of rapid aseptic loosening of cemented total hip arthroplasties who displayed a hypersensitivity reaction to *N,N*-dimethylparatoluidine (an accelerator found in the liquid methacrylate monomer component of bone–cement). An allergy to 1 of the constituents of bone–cement may cause an enhanced inflammatory reaction and accelerate the process of aseptic loosening. Although there are few long-term studies in the literature reporting the outcome of implantation in methyl methacrylate–allergic patients, we believe that cemented implantation in such patients places them at risk for a systemic inflammatory response (which may present in a variety of patterns [9]) and implant failure resulting from aseptic loosening. In the case presented, the patient had a hypersensitivity to the liquid methacrylate monomer (and polymerized bone–cement), although it is unclear to which component of the monomer she was specifically hypersensitive because direct testing of the various monomer components was not done.

The currently accepted model of contact allergy describes a delayed-type hypersensitivity reaction that develops in a genetically susceptible individual [9]. A hapten, such as *N,N*-dimethylparatoluidine, conjugates with a body protein, which creates a neoantigen capable of stimulating an immune response. This unique antigen is processed by dendritic cells or macrophages and presented to T cells, generating a cell-mediated, inflammatory response [9,10].

Acrylates, which are grouped under the more generic name of *acrylics,* have a chemical structure allowing excellent adhesive capability. This material is used extensively in dental and orthopaedic procedures. Patients may come in contact with acrylics in cosmetics, paint, hearing aids, inks, surgical tape, rubber stamp making, and various other materials [11–15]. A thorough patient history is likely to uncover any exposure to these materials. In this case, our patient described prior exposure to acrylic fingernails and acrylics in a temporary dental implant, which enabled us to confirm the allergy and modify her treatment.

Contact dermatitis resulting from exposure to methyl methacrylate was reported in 1941 [16]. Several reports in the early 1970s involving dermatitis and loosening of the prosthesis alerted physicians to the possible role of a delayed-type hypersensitivity reaction to methyl methacrylate [17]. Monteny, Oleffe, and Donkerwolke [17] reported a case of a 76-year-old patient with a cemented endoprosthesis who experienced an allergy to methyl methacrylate monomer. Patch testing in this patient

was strongly positive at several different concentrations of methyl methacrylate monomer. These authors hypothesized that methyl methacrylate monomer, when pushed into the injured bone blood vessels during implantation, acts as the allergen to which the patient mounts an immune response. Monteny, Oleffe, and Donkerwolke et al [17] did not report the long-term follow-up or treatment of this patient.

Romaguera, Grimalt, and Vilaplana [18] reported a case of a 31-year-old patient with a fracture of the left femur who developed a deep infection after surgery that was treated with methyl methacrylate beads containing gentamicin. Fifteen days postoperatively, an eczematous patch was found on the patient's thigh. Later the patient experienced generalized urticaria and edema of the eyelids. The patient had no previous allergic history but had a family history of atopy. Patch tests were positive to several concentrations of methyl methacrylate. On removal of the beads, the lesions disappeared.

Foussereau and Cavelier et al [19] and Romaguera and Vilaplana et al [20] reported 2 separate cases of contact sensitivity to methacrylates in limb prostheses. Foussereau and Cavelier [19] reported a patient who experienced a reaction from an above-the-knee prosthesis, whereas Romaguera and Vilaplana [20] described contact sensitivity in a patient using a newly varnished prosthesis contaminated with acrylates. Other examples of allergy to methyl methacrylate in various settings have been reported in the literature. Kassis, Vedel, and Darre [21] reported 2 cases of contact dermatitis in nurses working with acrylic bone–cement. Freeman, Lee, and Gudmundsen [22] reported 4 cases of contact reactions to sculptured acrylic fingernails. Methyl methacrylate, because of its success as a potent adhesive, can be encountered in different settings leading to possible sensitization.

In patients with suspected allergy, we recommend the following approach. A complete patient history and physical examination are essential and can provide fundamental information regarding a possible allergy. In addition, obtaining records from the patient's previous physicians may be useful in suspected allergy patients. In our case, the patient reported an allergy to acrylic fingernails and to a temporary dental implant. Work-up for an allergy to polymethyl methacrylate bone–cement or 1 of its components includes evaluation of a patch test. This test gives the most accurate information on the patient's allergy status. Evaluation can use a standard methacrylate series ((Meth)Acrylate Series MA-1000: Adhesives, Dental & Other/(Meth)Acrylate Series MN-1000: Nails-Artificial/Dental Series; Chemotechnique Diagnostics, Tygelsjo, Sweden) followed by placement of the antigens on the patient's back. The test site is examined at 72 hours to detect a delayed-type hypersensitivity reaction, manifested by edema, erythema, and vesicles [9]. An alternative method to conduct the patch test, as was used in our patient, involves formulating a 2% weight-to-weight mix of diluted liquid methacrylate monomer, the methacrylate copolymer powder, and polymerized bone–cement each in petrolatum and applying these to the skin. Further treatment of the patient should be based on conclusions drawn from the history, physical examination, and results of the patch testing.

The literature does not definitively report the prevalence of patients allergic to methacrylate. A study in 1980 reported, however, that in a cohort of 42 patients undergoing implantation of hip prostheses using cement containing methyl methacrylate, approximately 25% of the cohort showed a positive patch test 6 months after the operation [23]. With continual advances in cosmetics, dentistry, and various other industries, exposure and sensitization to methyl methacrylate may be rising. It is important to conduct a complete patient history and physical examination to detect this potential allergy before implantation of components with cement.

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