2008

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Foreign-Body Reaction Mimicking Postneurosurgical Infection after Cranioplasty

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ABSTRACT The case of a 57-year-old woman who suffered a fall is presented. After a polymethyl malacrylate revision cranioplasty, she presented with signs, symptoms, and intraoperative findings consistent with postneurosurgical infection. Dural foreign-body reaction was diagnosed, and parenteral antibiotic therapy was discontinued successfully.

CASE REPORT

Seventeen months before presentation at our facility for a revision cranioplasty, a previously healthy, 57-year-old woman suffered a fall and developed an acute subdural hematoma. She underwent urgent craniectomy at another site, as well as cranioplasty with preserved skullcap 3 months later. She gradually returned to normal function. Over the next year, the patient reported worsened contour of the site. Progressive resorption of her replaced skullcap was apparent on examination, and computed tomography revealed erosion. A synthetic cranioplasty flap was constructed for the patient at our facility by using polymethyl malacrylate (PMMA), subsequently sterilized in ethylene oxide, and was exchanged for the grossly resorbed skullcap with excellent alignment and approximation. It was secured with two 4-mm titanium screws and a dog bone-shaped titanium plate. Antibiotic irrigation solution was used. A small implant reapproximating the right temporalis muscle also was placed.

Two weeks after revision cranioplasty, the patient presented to the neurosurgery clinic reporting subjective fever, headaches, fatigue, incontinence, and decreased higher executive functioning, which developed slowly after she returned home earlier in the month. The patient was afebrile, with normal vital signs. She was tired and appeared uncomfortable. However, she had unremarkable, nonfocal, physical examination findings. Her cranial incision was well approximated and without incisional drainage, erythema, tenderness, or fluctuance. Her white blood cell count was 13,800 cells per mm^3. The differential count was remarkable for relative lymphopenia (20%) and mild absolute eosinophilia (900 cells per mm^3). No bands were identified, and the patient had 66% neutrophils in her differential count. Her erythrocyte sedimentation rate was 67 mm/h. Computed tomography revealed a 1.5- to 2-cm fluid collection beneath the acrylic plate (Fig. 1). Once admitted, the patient had a temperature of 103.1°F.

The patient was taken to the operating room. A right-sided, cranial, reverse-question mark, curvilinear incision was opened. The scalp and galea were reflected anteriorly and inferiorly. The titanium screws and plate and then the acrylic implant were removed. The fluid collection was visualized; it had a brownish, dishwater-like consistency. After evacuation, a drain was placed and the wound was irrigated. No cerebrospinal fluid leak was apparent. The galea was reapproximated, and the scalp was closed. The patient began empirical vancomycin and meropenem therapy. With the exception of mild postoperative fever up to 101.1°F within 48 hours after the procedure, the patient's recovery was unremarkable. Aerobic and anaerobic cultures, in conventional media, of the evacuated fluid and nutrient broth washes of the extracted hardware yielded negative results. Histopathologic analysis of the evacuated material revealed small quantities of dural tissue and revealed no signs of bacteria, fungi, mycobacteria, or parasites. However, chronic eosinophilic and granulomatous inflammation with polarizable foreign material was observed (Fig. 2). The patient underwent intraoperative drain removal, wash, and acid-fast bacillus sampling before discharge. That culture also yielded negative results. A diagnosis of foreign-body reaction was made.

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This work was presented at the 2006 Navy Chapter American College of Physicians Meeting, October 11–14, 2006, Bethesda, MD.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Uniformed Services University, the Department of Defense, or the U.S. government.

This manuscript was received for review in September 2007. The revised manuscript was accepted for publication in March 2008.

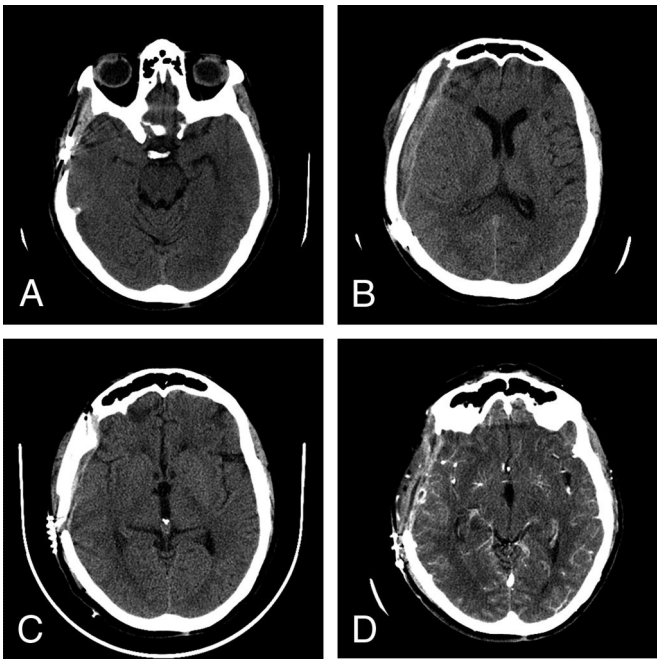

FIGURE 1. Computed tomographic scans. *A*, Resorbed right frontoparietal autologous skull. *B*, After revision cranioplasty with an acrylic plate. *C*, Subdural fluid collection with symptoms. *D*, After craniectomy, with improved symptoms.

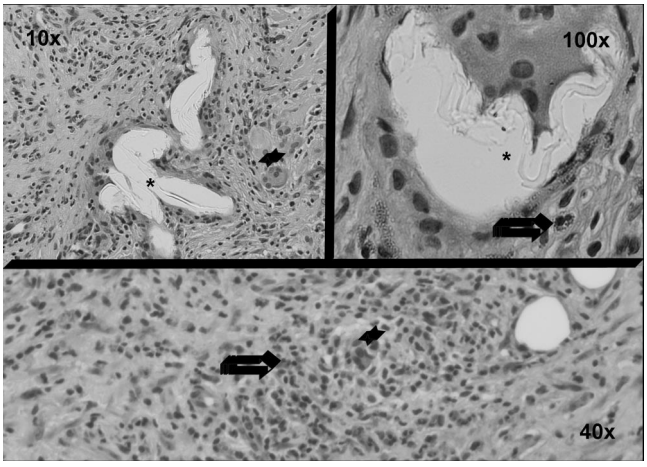

FIGURE 2. Photographs of a hematoxylin/eosin-stained section of the patient's dura adherent to the removed cranioplasty material. Chronic eosinophilic (arrows) and granulomatous (stars) inflammation with polarizable foreign material (asterisks) can be seen. Cultures and special stains of the specimen yielded negative results for conventional bacteria, fungi, and mycobacteria.

The patient completed 5 days of meropenem therapy and a 14-day course of vancomycin. Her leukocytosis resolved postoperatively. She reached a peak of eosinophilia of 2,900 cells per mm^3 1 week after the procedure, which slowly abated to normal by 6 weeks after the procedure. The patient returned to her functional baseline and subsequently underwent revision cranioplasty with a similarly fashioned acrylic implant, achieving good results without complications.

DISCUSSION

This patient presented with a suspected postneurosurgical infection and was found to have symptomatic foreign-body reaction. Although not previously reported in the setting of newer acrylic cranioplasties, postsurgical foreign-body reaction is a known phenomenon. An early series of steel mesh-acrylic cranioplasties included a single patient with a persistent exudate thought to be secondary to a foreign-body reaction.[1] Relevant to this patient's procedures, skin-filling acrylic, sponges, and antibiotic-impregnated ventricular catheters all have been implicated in foreign-body reaction.[2–5] One patient suffered fatal anaphylaxis after cranial acrylic implantation.[6] In contrast to the large number of cases of acrylic plastic implantation at various body sites, the incidence of clinically manifest foreign-body reactions appears to be low.

Tissue effects of acrylic plastics have been reported sporadically since the 1950s. A 1952 study evaluated changes in long bones by killing pigs 2 months after acrylic implantation.[7] Little change was observed. In rats, use of various acrylics both in brain tissue and in subcutaneous tissues failed to generate a foreign-body reaction.[8,9] Another study in rats, using acrylic microspheres of two acrylic varieties, one related to PMMA, yielded varying degrees of foreign-body reaction after implantation in the soft tissues of the face.[10] Translation from these animal studies is problematic, and the literature may suffer from both reporting biases and difficulties in diagnosis.

Sterilization methods, including the use of ethylene oxide, with implantable acrylics are known to result in fibrous sheath formation and inflammation.[11,12] However, ethylene oxide use does not seem to be worse than the use of irradiation, heat, or supercritical carbon dioxide.

The presence of polarizable material in the histopathologic evaluation of this patient's involved dura implicates PMMA. However, this patient later tolerated a similarly fashioned implant. Whether transient factors contributed to this difference is unclear. Ethylene oxide sterilization and subsequent preimplantation wash steps are potential exacerbating factors. A total of 145 patients have received cranial implants fabricated and implanted at our facility since 2001; nearly all of these have been war casualties. This is the first such rejection.

Reported infection rates for cranioplasty with acrylic plates vary and are derived from heterogeneous populations. However, rates from <5 to 20% have been reported.[13,14] When foreign-body reaction can be diagnosed, potential complications of long-term antibiotic treatment can be avoided. These complications include *Clostridium difficile* colitis, antibiotic toxicities (in particular, bone marrow suppression with high-dose meropenem or other β-lactam-like antibiotics), and risks of indwelling catheters (including catheter-related bloodstream infections and venous thrombosis). This patient was spared 9–16 days of high-dose meropenem ther-

apy, up to 7 days of vancomycin therapy, and percutaneous indwelling catheter access. These reductions translate into significant cost savings.

There are potential pitfalls to making such a diagnosis. Indolent organisms associated with the presence of hardware, such as coagulase-negative staphylococci and *Propionibacterium acnes*, can be difficult to culture, particularly in the setting of empiric antibiotic therapy and perioperative prophylactic antibiotic treatment. Some infections, such as those caused by the atypical mycobacteria, are associated with both eosinophilia and eosinophilic tissue infiltration. Although we think that acid-fast bacillus stains and cultures should be included in the evaluation of such patients, cranioplasty infection caused by mycobacteria has not been reported in Medline. For our patient, the peripheral eosinophilia and characteristic histopathologic findings made foreign-body reaction the likely diagnosis. A multidisciplinary approach seems optimal, incorporating neurosurgery, pathology, infectious diseases, and maxillofacial prosthetics expertise.

CONCLUSIONS

Foreign-body reaction after cranioplasty can mimic postneurosurgical infection. Recognition of the correct diagnosis can reduce the amount of antibiotic exposure and potentially the duration of venous access. Initially, these cases should be treated as infections.

REFERENCES

1. Tysvaer AT, Hovind KH: Stainless steel mesh-acrylic cranioplasty. J Trauma 1977; 17: 231–3.
2. Bell RS, Vo AH, Cooper PB, Schmitt CL, Rosner MK: Eosinophilic meningitis after implantation of a rifampin and minocycline-impregnated ventriculostomy catheter in a child: case report. J Neurosurg 2006; 104(Suppl 1): 50–4.
3. Christensen L, Breiting V, Janssen M, Vuust J, Hogdall E: Adverse reactions to injectable soft tissue permanent fillers. Aesthetic Plast Surg 2005; 29: 34–48.
4. Kawamura JY, Domaneschi C, Migliari DA, Sousa SO: Foreign body reaction due to skin filler: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006; 101: 469–71.
5. Turgut M, Akyuz O, Ozsunar Y, Kacar F: Sponge-induced granuloma ("gauzoma") as a complication of posterior lumbar surgery. Neurol Med Chir (Tokyo) 2005; 45: 209–11.
6. Meel BL: Fatal systemic allergic reaction following acrylic cranioplasty: a case report. J Clin Forensic Med 2004; 11: 205–7.
7. Henrichsen E, Jansen K, Krogh-Poulsen W: Experimental investigation of the tissue reaction to acrylic plastics. 1952. Clin Orthop Relat Res 1998; (352): 4–6.
8. Fernandez-Cossio S, Castano-Oreja MT: Biocompatibility of two novel dermal fillers: histological evaluation of implants of a hyaluronic acid filler and a polyacrylamide filler. Plast Reconstr Surg 2006; 117: 1789–96.
9. Winn SR, Aebischer P, Galletti PM: Brain tissue reaction to permselective polymer capsules. J Biomed Mater Res 1989; 23: 31–44.
10. Horak D, Adamyan A, Golubeva O, Skuba N, Vinokurova T: Poly(2-hydroxyethyl methacrylate) microspheres/liquid poly(dimethylsiloxane) composition for correction of small defects in face: histological evaluation in animal experiment. J Mater Sci Mater Med 2006; 17: 123–9.
11. Zhang YZ, Bjursten LM, Freij-Larsson C, Kober M, Wesslen B: Tissue response to commercial silicone and polyurethane elastomers after different sterilization procedures. Biomaterials 1996; 17: 2265–72.
12. Hill CM, Kang QK, Wahl C, et al: Biocompatibility of supercritical CO_2-treated titanium implants in a rat model. Int J Artif Organs 2006; 29: 430–3.
13. Matsuno A, Tanaka H, Iwamuro H, et al: Analyses of the factors influencing bone graft infection after delayed cranioplasty. Acta Neurochir 2006; 148: 535–40.
14. Benzel EC, Thammavaram K, Kesterson L: The diagnosis of infections associated with acrylic cranioplasties. Neuroradiology 1990; 32: 151–3.