

Allergic Epidural Effusion Following Polyetheretherketone Cranioplasty

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Abstract: Cranioplasty is a common procedure in neurosurgical practice. However, some complications may occur after the operation. We here presented a case of bilateral skull defect and underwent cranioplasty with polyetheretherketone (PEEK) prosthesis. The patient developed epidural effusion on both sides 7 days after surgery. The effusion was light yellow and transparent, and laboratory examinations revealed normal glucose level, negative bacteriological results, and increased IgG protein concentration. The effusion disappeared after treatment with dexamethasone and drainage. We speculated that the epidural effusion was because of delayed type allergic reactions after PEEK cranioplasty. However, further studies are needed to investigate its related mechanisms.

Key Words: allergic reaction, cranioplasty, epidural effusion, polyetheretherketone

Cranioplasty is a common procedure in neurosurgical practice.^{1,2} It is performed to reconstruct the bone defect following decompressive craniectomy. The purpose of cranioplasty is not only to provide protection of brain, but also to restore cosmetic contour and to give psychological and social benefits.^{2,3} Although the procedure of cranioplasty is generally considered safe, there are still some challenges. Complications including wound infection, epidural and subdural hematoma, bone reabsorption, cerebral edema, and allergic reaction may occur after cranioplasty.⁴ In addition, the search for ideal materials for cranial reconstruction is also one of the most critical challenges faced by neurosurgeons. The ideal materials should possess several important characteristics including: viability, ready availability, osteoconductivity, biocompatibility, easy to manipulate, and lower costs.^{1,5} The materials currently used for cranioplasty include autologous bone flap, calcium phosphate bone cement, titanium mesh, polymethylmethacrylate (PMMA), and polyetheretherketone (PEEK). All materials have their advantages and disadvantages, and allergic reaction to alloplastic materials is one of the most important disadvantages. Allergic reactions following acrylic, PMMA, and titanium mesh cranioplasty have been reported in literature.^{6–9}

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In recent years, there is an increasing interest in PEEK as a material for cranioplasty. Because of its lack of thermal variation, absence of heat conduction, and also its ease of handling, PEEK is considered an ideal candidate for cranioplasty implants.¹⁰ Cranioplasty with PEEK implant has also been reported to result in a lower infection risk than cranioplasty with titanium mesh or autologous bone.¹¹ PEEK has been used for cranial reconstruction since the early 2000s.¹² Nevertheless, studies regarding the outcomes of PEEK cranioplasty are still limited. To our knowledge, there is no case reported in literature about allergic reactions following PEEK cranioplasty. In this study, we presented a case of delayed-type allergic reactions following PEEK cranioplasty.

CLINICAL REPORT

A 25-year-old man sustained a closed head injury in a traffic accident 3 months ago. He was transferred to local hospital and head computed tomography (CT) scan revealed right-sided subdural hematoma and brain contusion. A right-sided decompressive craniectomy was performed with evacuation of hematoma emergently. However, a late-onset epidural hematoma developed on the left side after the surgery. Then a craniectomy was performed on the left side. The patient recovered well after surgery, and was transferred to rehabilitation facility after being discharged from the neurosurgical department. Three months after the initial injury, the patient was conscious and improved greatly in neurological functions, however, with bilateral skull defect. Therefore, he went to our department for cranioplasty.

Head CT scan and 3-dimensional reconstruction imaging performed after admission confirmed bilateral skull defect (Fig. 1A, B, C). After preoperative evaluation, right cranioplasty was performed under general anesthesia. Briefly, skin incision was made following the original craniotomy; the scalp was gently separated to avoid damage to the dura. A PEEK implant was positioned and secured properly in the bone defect. The bleeding was well controlled and the dura mater was carefully protected during surgical process. A small suction drain was left in place to help remove any excess fluid before the incision was sutured. The surgery was uneventful, and postoperative CT scan performed 1 day after surgery showed that PEEK implant was in ideal position, and no effusion or hematoma was observed (Fig. 1D). The subcutaneous drain was removed 2 days after the surgery. Seven days after the surgery, however, the patient complained of headache on the surgical area. Physical examination was not significant, and head CT scan showed epidural effusion (Fig. 1E). Subcutaneous puncture and drain were

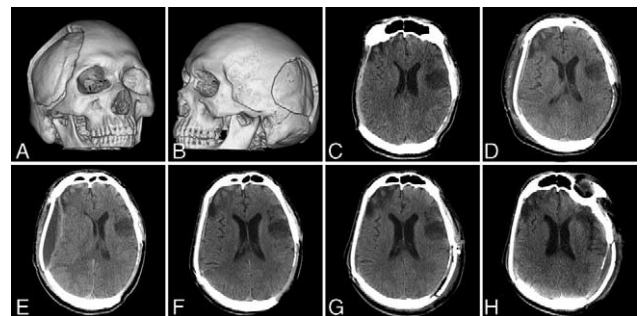


FIGURE 1. Head computed tomography (CT) scan and three-dimensional reconstruction imaging performed after admission showed bilateral skull defect (A–C). Postoperative CT scan conducted 1 day after right cranioplasty showed that polyetheretherketone implant was in ideal position, and no effusion or hematoma was observed (D). Head CT scan performed 7 days after surgery demonstrated right epidural effusion (E). The effusion disappeared after treatment with drainage and dexamethasone (F). Postoperative CT scan performed 1 day after left cranioplasty showed no abnormal effusion or hematoma (G). Epidural effusion developed 7 days after left cranioplasty (H).

performed; the effusion was light yellow and transparent. Laboratory examinations of the effusion showed elevated IgG (52 mg/dL) protein concentration (local reference range: 0.45–5.86 mg/dL), whereas IgE (41.4 KU/L) protein concentration was within normal range (local reference range: 0–100 KU/L). The glucose level was normal (4.3 mmol/L) and bacteriological results were negative. Dexamethasone was administered intravenously at a dose of 10 mg/day. The effusion gradually disappeared during CT follow-up (Fig. 1F).

Twenty seven days after the right cranioplasty, the left cranioplasty was performed with PEEK implant. The surgery was successful and postoperative CT scan showed no abnormal effusion or hematoma (Fig. 1G). However, the patient had a headache on the left side 7 days after the surgery, and head CT scan demonstrated left epidural effusion (Fig. 1H). The appearance and laboratory examination results of the effusion were similar to that on the left side previously: increased level of IgG protein, normal glucose level and negative bacteriological results. The treatment also involved subcutaneous drainage and administration of dexamethasone, and the patient recovered well and was discharged 7 days later.

DISCUSSION

In this study, we reported a rare case of epidural effusion probably because of allergic reaction following PEEK cranioplasty. Cranioplasty is a common and relatively safe procedure in neurosurgical department. Nevertheless, complications such as allergic reactions to alloplastic implants may occur after the surgery. Sinkin et al and Hettige et al^{7,8} have reported cases of allergic reactions after titanium cranioplasty. Meel⁶ reported a case of fatal systemic allergic reaction following acrylic cranioplasty. Gautschi et al⁹ have also reported a case of hypersensitivity to PPAM. PEEK is increasingly used in medical devices including cranioplasty material. So far, only 2 cases of allergic reactions to PEEK implant after surgery have been reported.^{13,14} One case developed chronic systemic allergy after spine surgery with PEEK implant.¹⁴ The other case suffered allergic reactions after rotator cuff surgery with PEEK implant.¹³ Recently, a meta-analysis about outcomes following PEEK cranioplasty including 183 cases demonstrated that infection was the most common complication after PEEK cranioplasty, followed by hematoma formation and implant exposure.¹² However, allergic reactions after PEEK cranioplasty were not reported.

In this case, the patient developed epidural effusion 7 days after cranioplasty with PEEK implant. Laboratory examinations of the effusion and the clinical history indicated that the patient suffered delayed type (type IV) allergic reactions to PEEK material, other than cerebrospinal fluid (CSF) leakage or bacterial infection. Because CSF will not collect into the epidural space if the dura mater remained intact, and the dura mater was confirmed intact during the surgery. The normal glucose level of the effusion and negative bacteriological results also precluded the possibility of effusion secondary to post-operative infection. Previous studies also reported that implant related allergic reactions are typically associated with type IV hypersensitivity.^{15,16} The increased IgG protein concentration in this case was probably due to non-specific immune response to surgical implant. As the lack of commercial testing substances for PEEK in our hospital, we were unable to perform allergic testing for this patient, such as allergen skin patch test.

Therefore, further studies are needed to elucidate the mechanisms of PEEK-induced allergic reactions.

In previous studies, treatment of allergic reactions after cranioplasty with alloplastic implants usually involved surgical removal of the implants.^{7,9} In this study, treatment included subcutaneous drainage and intravenous administration of dexamethasone. Then the epidural effusion disappeared and the patient recovered well during follow-up. To our knowledge, this is the first case report in literature about allergic reaction after PEEK cranioplasty. Given the increasing interest in PEEK implant as the material for cranioplasty, more studies will add to the evidence about outcomes following PEEK cranioplasty.

CONCLUSIONS

Allergic reaction after PEEK cranioplasty is rare but may cause devastating consequence. Examinations including an allergological investigation should be performed when symptoms of an incompatibility reaction occurred. More data are needed in the future to study the related mechanism and outcomes of allergic reaction following PEEK cranioplasty.

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