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Case Report

Burr hole on polyetheretherketone cranioplasty for the management of chronic subdural hematoma: A case report

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ABSTRACT

Background: In rare cases, chronic subdural hematoma can be a complication following cranioplasty implantation. Therefore, it can develop spontaneously or after a trauma in the underlying site of a duroplasty and represent, if compression of the brain structures, a life-threatening condition. In case of a patient with cranioplasty in polyetheretherketone (PEEK), performing a burr hole on prosthesis can represent, although unusual, an effective and safe technique for evacuation of the chronic subdural hematoma, avoiding the need to remove the prosthesis itself. Nevertheless, a rare and insidious prosthesis infection can occur, even after years.

Case Description: A 54-year-old male patient, following severe traumatic brain injury, underwent a right hemispheric decompressive craniectomy associated to acute subdural hematoma evacuation and, subsequently, a PEEK cranioplasty implant with polytetrafluoroethylene (PTFE or Gore-Tex) duroplasty. About 10 years later, he experienced worsening headache with sensory alterations; therefore, he underwent a brain computed tomography scan documenting a right hemispheric chronic subdural hematoma (cSDH), expanding in subsequent radiological examinations. Because of symptoms' worsening, he underwent cSDH evacuation through a burr hole centered on the parietal region of the PEEK prosthesis, associated with mini-reopening of duroplasty. Two years after the procedure, he went to the emergency department because of the appearance of a serum-purulent material drained from the surgical site. He underwent cranioplasty removal and then started a targeted therapy to treat a triple surgical site infection, often unpredictable and totally accidental.

Conclusion: Based on the literature evidence, performing a burr hole on a cranial prosthesis in bone-like material such as PEEK represents a surgical procedure never performed before and in our opinion could, in selected cases, guarantee the cSDH evacuation and the treatment of intracranial hypertension, avoiding the cranioplasty removal, although there is a risk of even late surgical site infection.

Keywords: Burr hole, Chronic subdural hematoma, Cranioplasty, Gore-Tex, PEEK, Surgical site infection

INTRODUCTION

In rare cases, chronic subdural hematoma (cSDH) can be a complication following cranioplasty implantation.[3] It can, therefore, develop spontaneously or after a trauma in the underlying site of a duroplasty and represent, if compression of the brain structures, a life-threatening condition. The PTFE duroplasty represents a safe material used in cranial reconstruction procedures. It is made of

three layers: the two outer layers characterized by the presence of micropores and the half one thanks to its elastomeric properties ensures a good engraftment reducing the risk of leakage. Like the patient with coagulative alterations and without anatomical alterations, in the case of a patient with polyetheretherketone (PEEK) cranioplasty, performing a burr hole on prosthesis can represent, although unusual, a safe and effective surgical technique for cSDH evacuation, avoiding the need to remove the prosthesis itself. The main risk associated with this procedure is related to the high rate of prosthesis infection. *Staphylococcus aureus*, *Staphylococcus haemolyticus,* and *Acinetobacter lwoffii* are saprophytic microorganisms mostly found on skin surface that can cause opportunistic infections even after a neurosurgical procedure.[2,5,10]

CASE DESCRIPTION

A 54-year-old male patient, following severe head trauma associated to acute subdural hematoma [Figure 1], underwent a right hemispheric decompressive craniectomy, a SDH evacuation and, subsequently, a cranioplasty implant with a polyetheretherketone (PEEK, Stryker Craniomaxillofacial Kalamazoo, MI, USA) and polytetrafluoroethylene (PTFE or Gore-Tex, GORE® PRECLUDE® PDX Dura Substitute, WL Gore and Associates, Inc., Flagstaff, Arizona) duroplasty [Figure 2]. About 10 years later, he presented worsening headache with sensory alterations; therefore, he underwent an urgent brain CT scan that showed a right hemispheric cSDH expanding in subsequent radiological examinations [Figure 3]. Because of symptoms' worsening, he underwent cSDH evacuation through a burr hole centered on the parietal region of the PEEK prosthesis, associated with mini-reopening of duroplasty. During the burr hole procedure, an antibiotic prophylaxis was performed (once-daily intravenous dose of cefazolin 1 g and once-daily intravenous dose of teicoplanin 400 mg). Subsequent postoperative brain computed tomography (CT) scan documented a progressive brain re-expansion, associated with a significant clinical-neurological improvement that allowed him to be discharged in postoperative day 5. Two years after the procedure, he was admitted to the emergency department because of the appearance of a serum-purulent material drained from the previous surgical site. He underwent a brain CT scan that showed a 3 cm gas-fluid collection extending from the subdural to the epidural space and communicating through the burr hole [Figure 4]. PEEK cranioplasty removal was performed. A purulent mixed to necrotic material was found, with a severe pial congestion. A debridement of the surgical site was performed with copious antibiotic-impregnated irrigation and a new duroplasty was performed [Figure 5]. Postoperative course was uneventful. From the bacteria, culture tests resulted that a high positivity rate for *S. aureus*, *Streptococcus haemolyticus,* and *Acinetobacter lwoffii* was found and a targeted antibiotic therapy (twice-daily intravenous dose of ceftriaxone 1 g and once-daily intravenous dose of INN-daptomycin 500 mg) was administered. The patient was discharged on the 14th postoperative day with inflammatory index and white blood cells count within normal range. A novel titanium custom-made cranioplasty was performed after 3 months

Figure 1: Axial brain computed tomography (CT) scan image showing a severe traumatic brain injury associated to an acute right hemispheric subdural hematoma.

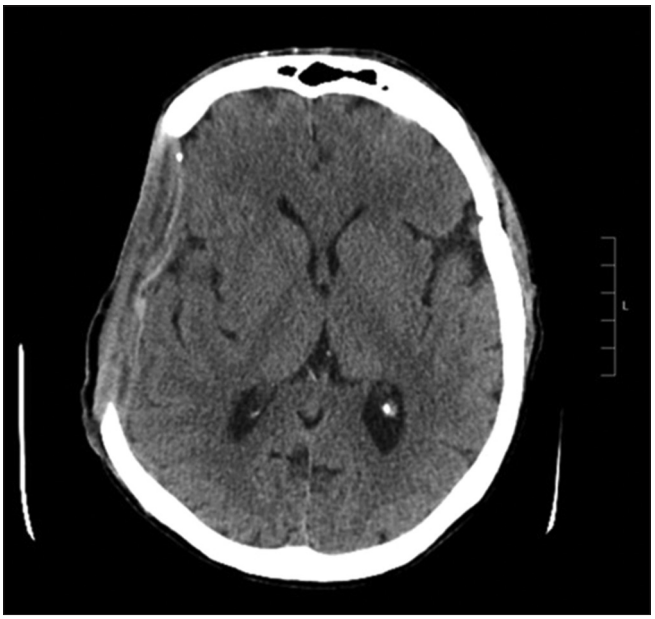

Figure 2: Axial brain CT scan image showing Gore-Tex duraplasty after the right hemispheric decompressive craniectomy.

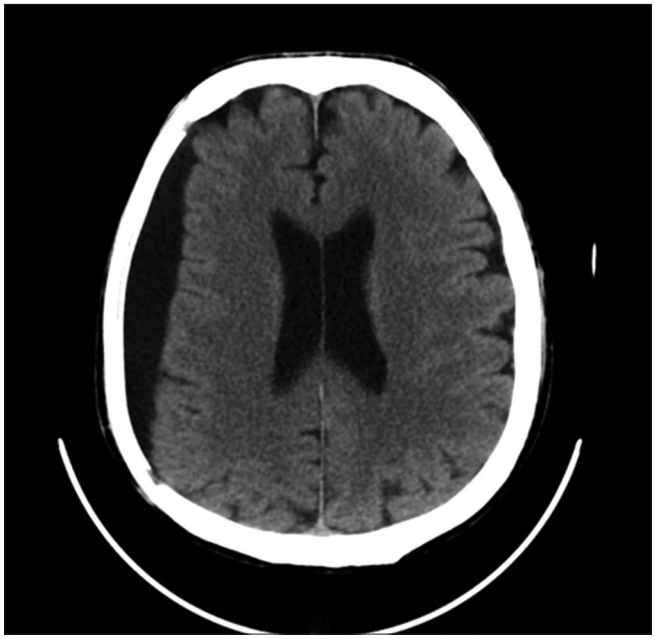

Figure 3: Axial brain CT scan image showing right hemispheric chronic subdural hematoma 10 year after polyetheretherketone (PEEK) cranioplasty implant.

Figure 4: Axial brain CT scan image showing a 3 cm gas-fluid collection extending from the subdural to the epidural space and communicating through the burr hole.

because the patient presented the "sinking skin flap" syndrome. After 2 weeks, he presented a complete recovery with return to work.

DISCUSSION

cSDH represents a rare complication following cranioplasty implantation.[3] A literature review was performed and this

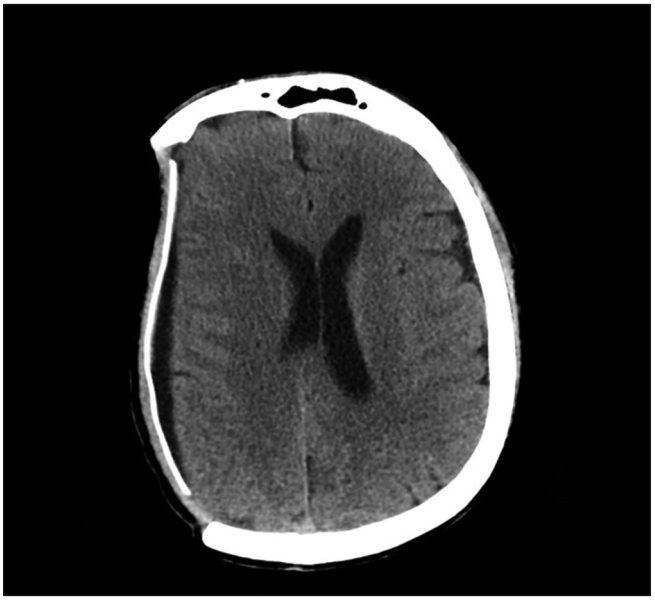

Figure 5: Postoperative axial brain CT scan image showing removal of the previous PEEK cranioplasty and the new duroplasty, in the absence of gas-fluid collections.

represents that a unique case was performing a burr hole on a PEEK cranioplasty represents a life-saving procedure avoiding implant removal. Polytetrafluoroethylene (PTFE), better known as Teflon, represents a fluoropolymer with a good thermal conductivity, strength, and chemical inert. These properties make this material advantageous in biomedical application where it can be used as expanded PTFE (e-PTFE), particularly found in neurosurgery in duroplasty as dural substitute called Gore-Tex.[4]

Messing-Jünger *et al*. showed 119 patients requiring duroplasty after surgery, demonstrating Gore-Tex safety and manageability thanks to a good resistance against engraftment and colonization by pathogens.[8] Although the patient has benefited from this procedure for several years, prosthesis burr hole and duroplasty opening acted as a "crossroads" between subdural/epidural spaces and skin, with a high risk of infection, as it happened in the present case. *S. aureus*, *S. haemolyticus,* and *A. lwoffii* are the bacteria found in bacterial culture after debridement of the surgical site. One of the most common among nosocomial infections is due to *S. aureus*, despite all the cases of community-acquired infections that have increased in the last decade.[8] Sheen *et al*. demonstrated that this bacterium can invade and destroy the blood–brain barrier – endotheliocytes migrating from the bloodstream to the brain parenchyma or meninges.[11] Indeed, a skin saprophytic microorganism is capable of penetrate from the outside extending through the Gore-Tex burr hole. Furthermore, *S. aureus*, determining connective tissues necrosis, can cause gas production.[10] As in the present case, gas produced by this microorganism, has

reached subdural space developing the air levels highlighted in the brain CT scan.

As far as we know, this infection was the *primum movens* causing the colonization from other microorganisms. In fact, intraoperatively, a congested tissue was found because of the release of numerous pro-inflammatory factors[7] that clearly affected the barrier mechanisms simplifying the colonization by the others two bacteria. The coinfection reported in the present case, according to a literature review, represents a very rare and isolated episode. In fact, although *S. aureus* is a bacterium frequently involved in polymicrobial infections, bacteria most frequently involved in coinfections are *Haemophilus influenzae*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Streptococcus pneumoniae*, *Corynebacterium* spp., and *Lactobacillus* spp.[9]

The second bacterium involved in the surgical site infection was *S. haemolyticus*. This is a methicillin-resistant coccus and represents the main opportunistic pathogen related to infections in head trauma or in patients who underwent a neurosurgical procedure. This bacterium can cause postoperative meningitis in adult patients, as well as infections of many implantable devices.[1,2,12] *A. lwoffii*, the last one discovered in the bacterial culture, is a multidrug-resistant bacterium, typically found on skin flora, oropharynx, and perineum in an average rate of healthy population. It can cause systemic infections, especially in immunosuppressed patients. This bacterium took advantage of acid pH and thermal stress, as purulent and necrotic-colliquative environment, to replicate and colonize its hosts.[8,6,11] Nevertheless, at the best of our knowledge, this is the first case of immunocompetent patient's prosthesis infection due to *A. lwoffii*, *S. aureus,* and *S. haemolyticus*. According to Hu *et al*.,[5] graft infections are the most common, even several years, after the cranioplasty has been performed, and they are often due to skin bacterial flora as in the case here reported. Indeed, there is still no consensus on reliable risk factors for both early and delayed graft infections; moreover, late ones are often unpredictable and totally accidental, as we reported.

Patient's manual work and related repeated traumatism, the precarious hygienic conditions as well as a poor skin trophism could have influenced the delayed onset of the infection after burr hole procedure, despite the regular antibiotic prophylaxis.

CONCLUSION

Based on the literature evidence, performing a burr hole on a cranial prosthesis in bone-like material such as PEEK and the duroplasty incision represents a surgical procedure never performed before and in our opinion could, in selected cases, guarantee the cSDH evacuation avoiding the cranioplasty removal. Nevertheless, delayed brain surgical site infections due to three different microorganisms represent a rare event and even more rare is the coinfection of heterologous materials used for bone reconstruction and duroplasty. There is still no consensus on reliable risk factors for delayed graft infections as they are often unpredictable and totally accidental, despite a regular antibiotic prophylaxis.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Azimi T, Mirzadeh M, Sabour S, Nasser A, Fallah F, Pourmand MR. Coagulase-negative *Staphylococci* (CoNS) meningitis: A narrative review of the literature from 2000 to 2020. New Microbes New Infect 2020;37:100755.
2. Chang WN, Lu CH, Huang CR, Chuang YC. Mixed infection in adult bacterial meningitis. Infection 2000;28:8-12.
3. Chaturvedi J, Botta R, Prabhuraj AR, Shukla D, Bhat DI, Devi BI. Complications of cranioplasty after decompressive craniectomy for traumatic brain injury. Br J Neurosurg 2016;30:264-8.
4. Dhanumalayan E, Joshi GM. Performance properties and applications of polytetrafluoroethylene (PTFE)-a review. Adv Compos Hybrid Mater 2018;1:247-68.
5. Hu Y, Li X, Zhao R, Zhang K. Conservative treatment for delayed infection after cranioplasty with titanium alloy. J Craniofac Surg 2018;29:1258-60.
6. Ku SC, Hsueh PR, Yang PC, Luh KT. Clinical and microbiological characteristics of bacteremia caused by *Acinetobacter lwoffii*. Eur J Clin Microbiol Infect Dis 2000;19:501-5.
7. McNicholas S, Talento AF, O'Gorman J, Hannan MM, Lynch M, Greene CM, *et al*. Cytokine responses to *Staphylococcus aureus* bloodstream infection differ between patient cohorts that have different clinical courses of infection. BMC Infect Dis 2014;14:580.
8. Messing-Jünger AM, Ibáñez J, Calbucci F, Choux M, Lena G, Mohsenipour I, *et al*. Effectiveness and handling characteristics of a three-layer polymer dura substitute: A prospective multicenter clinical study. J Neurosurg 2006;105:853-8.
9. Nair N, Biswas R, Götz F, Biswas L. Impact of *Staphylococcus aureus* on pathogenesis in polymicrobial infections. Infect Immun 2014;82:2162-9.
10. Saliba WR, Goldstein LH, Raz R, Mader R, Colodner R, Elias MS. Subacute necrotizing fasciitis caused by gas-producing *Staphylococcus aureus*. Eur J Clin Microbiol Infect

Di. 2003;22:612-4.
11. Sheen TR, Ebrahimi CM, Hiemstra IH, Barlow SB, Peschel A, Doran KS. Penetration of the blood-brain barrier by *Staphylococcus aureus*: Contribution of membrane-anchored lipoteichoic acid. J Mol Med (Berl) 2010;88:633-9.
12. Tian R, Hao S, Hou Z, Gao Z, Liu B. The characteristics of post-neurosurgical bacterial meningitis in elective neurosurgery in 2012: A single institute study. Clin Neurol Neurosurg 2015;139:41-5.

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