

Bioresorbable Plate Fracture After Cranioplasty Caused by Head Injury, a Pediatric Case

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Case report

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Abstract

Background: Recently, bone fixation materials have been developed as surgical materials. Bioabsorbable materials offers several advantages over other materials and are widely used. We report a rare case of the fracture of bioresorbable plates caused by head injury, and describe some considerations.

Case description: A day, six-year-old boy suffered from consciousness disturbance. He was admitted our hospital and diagnosed with left frontal subcortical hemorrhage due to ruptured arteriovenous malformation (AVM). He was received the surgery of removal of the AVM with decompressive craniectomy. He was discharged without any neurologic deficit and underwent the cranioplasty 4 months after the initial surgery. Two months after the last treatment, he was fallen and hit his left frontal head. The next day, he noticed an abnormal bulge in the injured area. We diagnosed the bulging as the cerebrospinal fluid leakage because of the dural tear. The repairment of dural tear was performed. We found that two bioresorbable plates used by cranioplasty were both cracked and the dura mater beneath them was teared. We repaired the damaged dura with an artificial dura mater. After surgery, cerebrospinal fluid leakage did not occur.

Conclusion: It has been reported that the durability of bioresorbable plate is no less than that of titanium plate. We experienced a relatively rare case in which bioabsorbable plate used for bone fixation was damaged due to head trauma. After craniotomy or cranioplasty using bioresorbable plates, special attention should be paid to head trauma that involves bone flap sinking force and side bending stress.

Introduction

Various bone fixation materials have been developed.^[9, 17] Though, bioabsorbable plates are slightly less durable than titanium plates, but are comparable to titanium plates in osteosynthesis. ^[1-3, 8, 12, 20] Bioresorbable osteofixation materials offers several advantages over titanium fixation, including the absence of the need to remove the implants after osseous healing, radiolucency, decreased pain. Considering these advantages, the use of bioresorbable plates is increasing, especially in pediatric cases. ^[4] We report a very rare case of the fracture of bioresorbable plates caused by head injury, and describe some considerations.

Case Report

Five-year and eleven-month-old boy presented with the left frontal subcortical hematoma due to ruptured AVM and underwent the removal of AVM with the decompressive craniectomy [Figure 1A,B]. Four months after the initial surgery, cranioplasty was performed using microporous hydroxyapatite (APACERAM®). We used two bioresorbable plates and eight screws (Lactosorb®) at frontal region and one titanium plate at temporal region to fix the artificial bone flap [Figure 1C]. He was discharged without any neurological deficit after initial treatment.

Nine weeks after the cranioplasty, he hit his left forehead on a refrigerator. Next day, he noticed an abnormal bulg in the injured area. He took a medical check at our department because of the bulging area was increased and there were no signs of recovery. At the time of our check, his consciousness was clear and he had no other neurologic deficit. The bulging area was located where we performed cranioplasty at the initial treatment. The bulging area was soft and there were no signs of inflammation.

Head Computed tomography (head CT) showed the fluid collection under the scalp and epidural space [Figure 2]. The CT Hounsfield number of this lesion was low, this finding was suggesting the collection of cerebrospinal fluid rather than that of bleeding. We speculated that the cerebrospinal fluid leakage had occurred due to a dural laceration at the previous surgical site. We decided to surgical repair this lesion based on our speculation.

Operative findings and follow-up

The previous skin incision was made and skin flap was flipped. Though, we found no fracture of the artificial bone flap, two bioresorbable plates previously we used were both fractured in the middle [Figure 3a]. After taking off the bone flap, there was a dural tear at the point of the bone edge and cerebrospinal fluid was leaking. [Figure 3b]. We repaired the injured dura with polyglycolic acid (Dura wave®) with fibrin glue. We fixed bone flap previously used again by a titanium plate. After the repairment, the bulging area was vanished and he was discharged without any adverse effects. We have followed him for three years, no troubles have seen of his skull.

Discussion

When we fixed the bone flap with metal wire or suture thread such as silk or nylon, the fixation was not enough and some problems often happened.^[3, 9] The osteofixation of titanium plate have been developed. Titanium plates are able to fix a bone flap easily but also rigidly. Thus, titanium plates are now widely used at craniotomy. However, adverse events associated with titanium plates are reported especially for pediatric case implanted for a long period. It is reported that deviation of the plates, inhibition of cranial bone growth, aberrance into brain, scalp thinning and plates exposure.^[6, 7, 9, 13, 18]

Recently, Various bioresorbable osteofixation implant materials have been developed. It have been reported that polyhydroxyl acids, poly-D-lactic acid, polyglycolic acid, etc. as materials. The first use of bioresorbable implants to animals was published in 1966 by Kulkarni et al. ^[10] Bioresorbable materials are inferior to titanium in terms of fixing strength, but have same biocompatibility as titanium. Several reports described that adverse effects were no difference between bioresorbable and titanium materials, so bioresorbable materials are not inferior to the titanium materials.^[1-3, 8, 12, 20]

Bioresorbable materials are absorbed in about a year, eliminating the need to remove the implant after osseous healing. And bioabsorbable materials benefit from reduced tactile sensation, pain, and

radiolucency. (Table 1).^[4, 9, 17] Because of those advantages described above, the use of them for pediatric cases have been increasing.

Our case showed the fracture of bioresorbable plates after head injury. Lactosorb® which we used in this case, is made from a copolymer of 82% poly-L-lactic acid and 18% polyglycolic acid. In vitro exposure, it is reported that it retains about 70% of initial shear strength after 8 weeks. Thus, it is considered that Lactosorb® fix strength has retained until natural osseous healing.^[11, 15, 19] The times of resorption of the copolymer plate is about a year.^[13] The screws made of the same material has about 80% of initial shear strength at four weeks and keeps the strength after that.^[16] It is also reported that bioresorbable plate has similarly bending and tensile stiffness as titanium plate but showed low side bending stiffness.^[14]

APACERAM® which we used as bone flap at cranioplasty is made from microporous hydroxyapatite. Newly formed bone was detected on the surface of the material and in the macropores near the surface 1 week after transplantation, and it was reported that the compressive strength of 10 MPa is maintained after 5 weeks.^[19]

This case was injured 8 weeks after the cranioplasty, and was thought to have been about 70% of the initial shear strength of the plate at that time. In this case, it was probable that the bone flap sank due to head injury and the bioabsorbable plate was subjected to lateral bending stress, resulting in division at the central part. As a result, the dura mater was injured by the edge of the bone flap and occurred the cerebrospinal fluid leakage and made the skin bulging.

By the time the bioabsorbable plate was absorbed, it is thought that bone healing and adhesion to peripheral bone would progress and shear strength would be maintained. In this case, the bioabsorbable plate was damaged by a head injury before such a condition occurred. This case indicated that it is necessary to pay much attention to early head injury after cranioplasty with bioresorbable plates.

Conclusion

We reported the case of the fracture of bioresorbable plates caused by head injury. After craniotomy or cranioplasty with using bioresorbable plates, it is necessary to pay attention for head injury, especially for bone flap sinking and side bending stress.

Abbreviations

AVM: arteriovenous malformation, CT: Computed tomography

Declarations

Declaration of patient consent

The authors certify that they obtained all appropriate patient and his/her parents consent forms. The patient and his/her parents understand that their names and initials will not be published, but anonymity cannot be guaranteed.

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none.

Conflict of Interest

All authors have no conflict of interest.

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Tables

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Figures

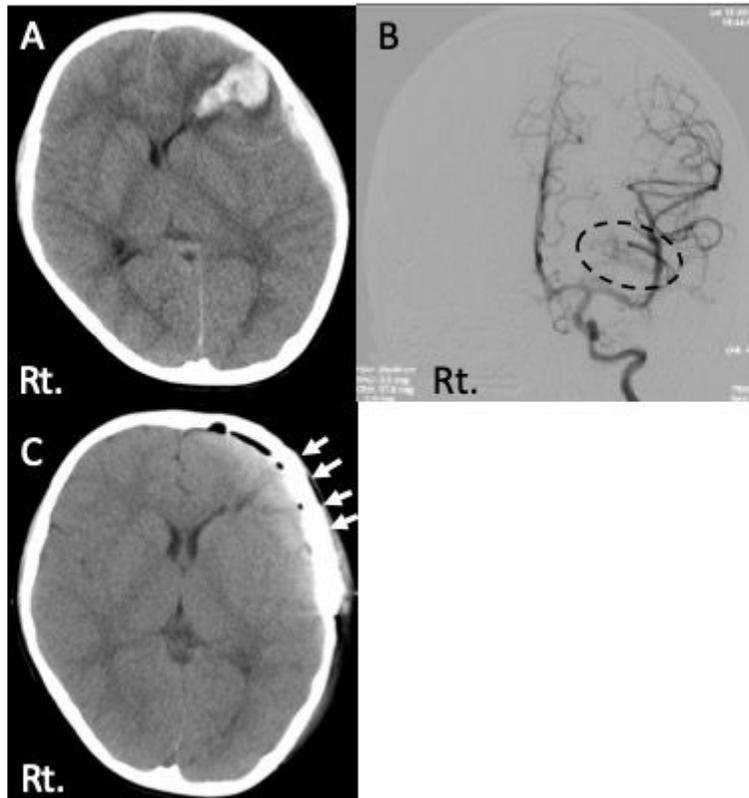


Figure 1

Radiological examinations at first treatment. (a) Head CT showed left frontal subcortical hematoma. (b) Cerebral angiography of left internal carotid artery showed AVM adjacent the hematoma (dotted ring). (c) CT image after cranioplasty.

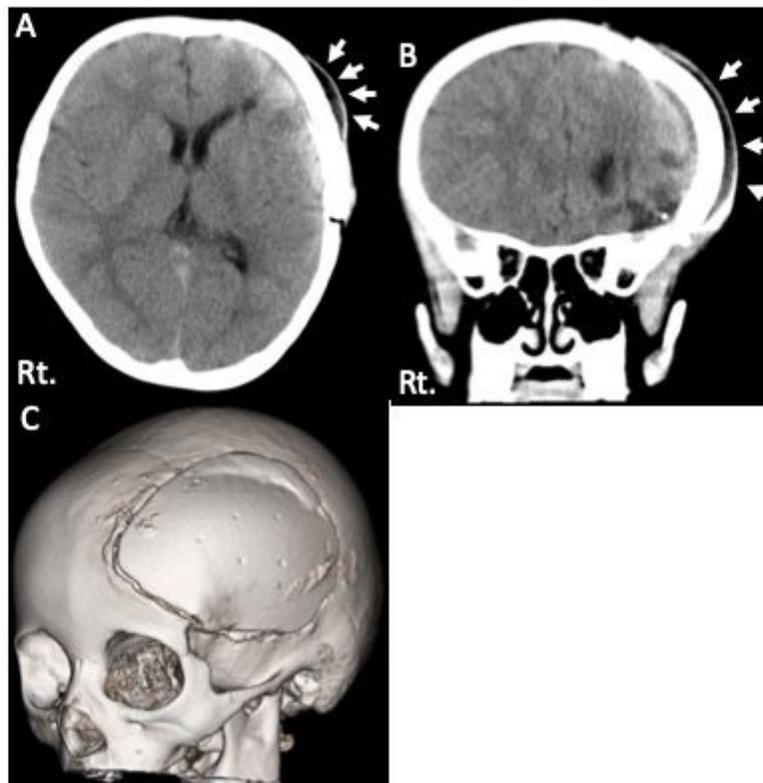


Figure 2

Radiological examination after head injury. (a, b) head CT showed subcutaneous fluid collection (white arrows). (c): Three-dimensional image showed relationship artificial bone flap and skull. No obvious deviation of the bone flap.

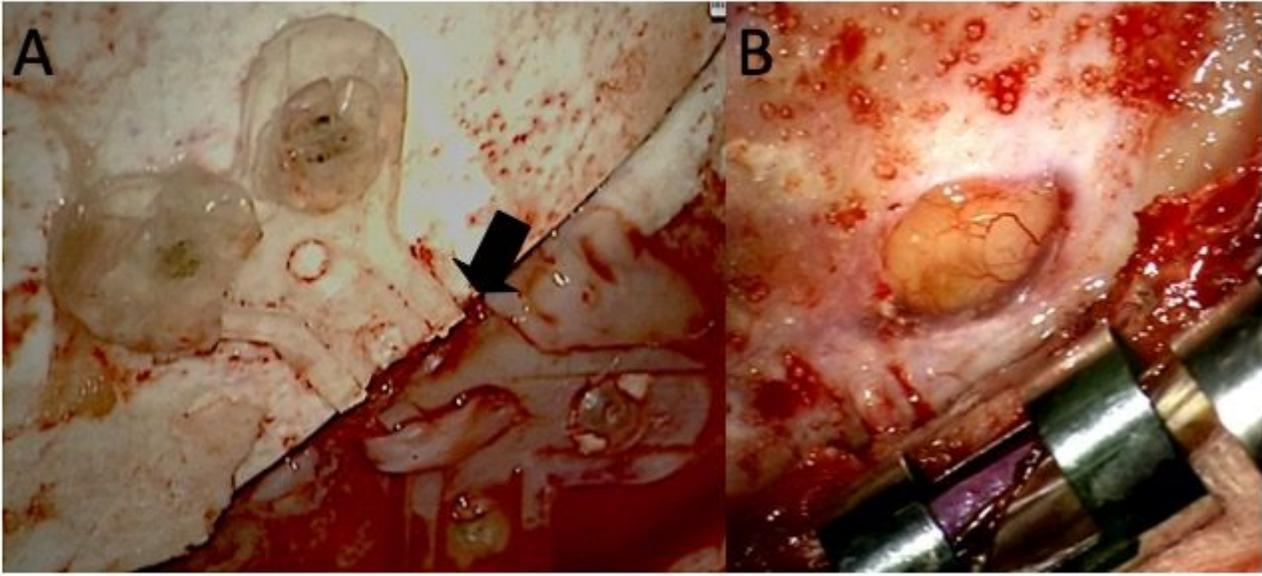


Figure 3

Intraoperative photos. (a) Bioresorbable plates were fractured in the middle (black arrow). (b) The dural tear at the edge of the bone flap and the cerebrospinal fluid were leaking at this point.

Supplementary Files

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- [table1.jpg](#)