

# Skull Perforation and Depressed Fracture Following Skull Fixation for Stereotactic Surgery

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We report an unusual case of skull perforation and depressed fracture with epidural hematoma in a 61-year-old woman who has been undertaken a skeletal fixation for stereotactic evacuation of intracerebral hematoma. Most neurosurgeons secure the patient's head in a skeletal fixation device with a three- or four-pronged pin-type headrest for stereotactic procedure or microsurgery. Although a variety of complications have been reported secondary to the use of head fixation devices, these potential complications of skull fixation have been infrequently described in the medical literatures. Consideration of calvarial thickness, tightening force, and adequate location of skull fixation may reduce the risk of skull perforation and depressed fracture.

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**KEY WORDS:** Complication · Depressed fracture · Epidural hematoma · Perforation · Stereotactic surgery.

## Introduction

The pin-type headrest is one of the most common equipment for the skull fixation for stereotactic neurosurgical procedures. This device clamps the patient's skull to rigid structure, and holds the patient's head and neck in a particular position during surgical procedures. Pin headrest device has brought conveniences and favorable outcomes in neurosurgical fields, but can develop hazardous complications. Particularly in pediatric patients, a case with skull penetration has been reported.<sup>8)</sup> However, a skull perforation and depressed fracture has uncommonly complicated in adults.<sup>13)</sup> We report a case with skull perforation and depressed fracture following skull fixation by pin headrest in an adult.

## Case Report

A 61-year-old woman presented with altered mentality which lasted for 2 hours. Neurological examination showed

drowsy mentality and left sided hemiparesis (Grade III). Initial computed tomography (CT) scans revealed an intracerebral hematoma (ICH) measuring 5.0×4.5×3.0 cm in the right basal ganglia (Figure 1). We decided a stereotactic procedure for removal of ICH. After securing her head with stereotactic frame (Fischer stereotactic head frame, Stryker Leibinger GmbH & Co., Freiburg, Germany), we obtained CT scans to calibrate the reference point. Penetrations of the skull with associated surrounding small bone chips from depressed fracture were observed just at the site of skull holder's pins. We also observed a small amount of epidural hematoma (EDH) in the left frontal region (Figure 2). Stereotactic-guided aspiration of ICH was performed under the local anesthesia and her level of consciousness did not change during the operation. The patient's postoperative course was uneventful and postoperative brain CT scans revealed no remarkable change except the minimally increased EDH in the left frontal region. But her level of consciousness declined at the 2nd day after the surgery, and follow-up CT scans revealed the increased volume of ICH in the right basal ganglia with displacement of the midline (Figure 3A). ICH was evacuated promptly with elevation of the depressed skull fracture (Figure 3B). But, the patient experienced a progressive deterioration of medical status by diabetes insipidus and rhabdomyolysis postoperatively, and she expired at the 10th day after the second surgery.

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## Discussion

Pin headrest is a standard skull-fixation device that has seen widespread use during neurosurgical procedures and

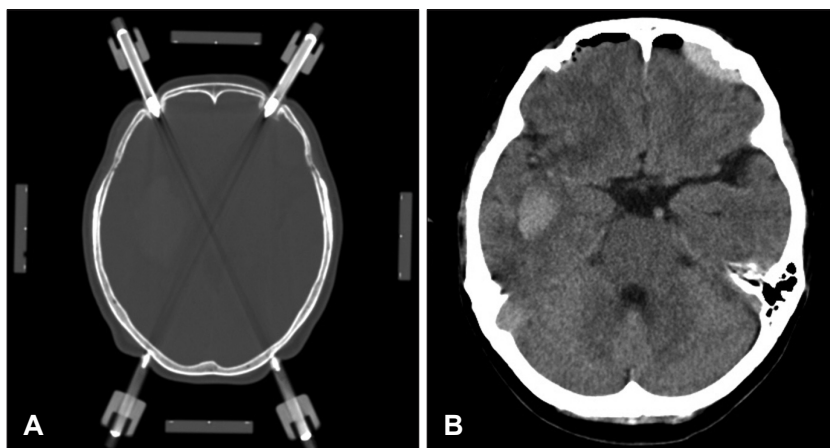


**FIGURE 1.** Preoperative brain computed tomography scan shows an intracerebral hematoma measuring  $5.0 \times 4.5 \times 3.0$  cm in the right temporal lobe with the small amount of perilesional edema.

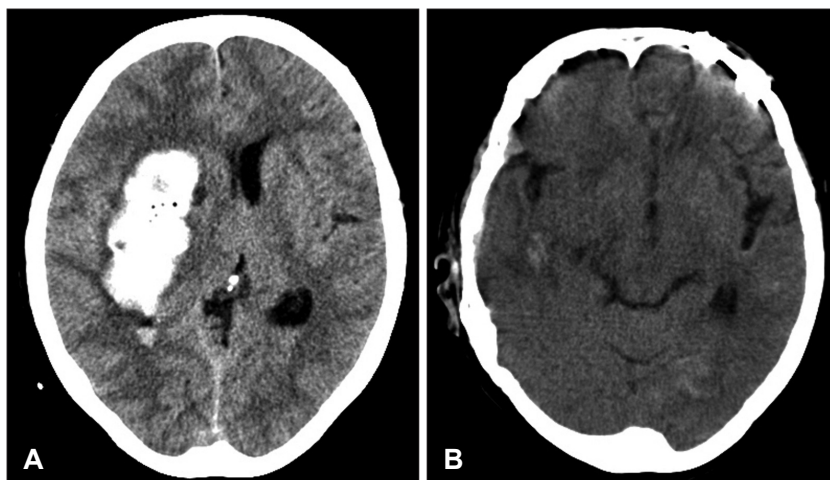
various modifications of pin headrests have been developed.<sup>2)</sup> It is designed to anchor the outer table of the cranial vault. Although they are commonly used for firm fixation of cranium during the operation, complication rate is relatively rare. Previous studies reported several complications of pin headrest including scalp perforation, slippage of the head, venous air embolism, penetration into the skull, epidural hematoma, tension pneumocephalus, traumatic aneurysm of the superficial temporal artery, and arteriovenous fistula between superficial artery and vein.<sup>1-5,7-9,11,14)</sup>

There were several reports with depressed skull fracture and penetration by the pin headrest, but most of them were pediatric neurosurgical patients.<sup>2,10)</sup> Depressed skull fracture by pin headrest is rarely developed in adult patients. Sade et al.<sup>13)</sup> reported a case of depressed skull fracture and epidural haematoma caused by pin headrest complicated the post-operative course in an adult, after removal of a parasagittal meningioma. That case was a patient with meningioma who had the presence of an extremely thin bone by the result of chronic raised intracranial pressure. However, our case has a normal thickness of skull. It means that we have not

**FIGURE 2.** Brain computed tomography (CT) scan for calibration of reference point reveals skull perforation in two pin sites of frontal bones (A). Brain CT scan demonstrates the depressed fractures of both frontal bones and the small amount of epidural hematoma in the left frontal region (B).



**FIGURE 3.** Brain computed tomography (CT) scan obtained at the 2<sup>nd</sup> day after stereotactic procedure shows the increased amount of intracerebral hematoma (ICH) in the right temporal lobe with midline displacement (A). Postoperative CT scan demonstrates the reduction of the depressed skull in the left frontal bone and removal of ICH in the right temporal lobe (B).



given sufficient precautions to prevent procedure-related complications. On the other hand, skull fracture is not usually associated with osteoporotic change.<sup>17)</sup> In our case report, we did not perform any studies related to osteoporosis because of the emergency for operation. EDH caused by pins is also infrequently developed. Palmer et al.<sup>12)</sup> reported that postoperative EDH has been developed in 0.3% among 6,668 neurosurgical procedures, but none of these patients were caused by pin headrest. Fukamachi et al.<sup>6)</sup> also reported that 168 out of 1,105 patients (15.2%) had postoperative EDH, but there were no patients with EDH caused by pin headrest.

Thickness and texture of the cranium can be important factors for the development of depressed skull fracture.<sup>2)</sup> In order to prevent these complications, we should avoid the thinner areas including the temporal squama, frontal sinus, and coronal suture as the site of skull pin fixation. On the other hand, the pressure adjusting mechanisms in the pin headrest make unlikely to penetrate the bone, it is also essential to evade a forceful pressure for fixation of headrest device.<sup>11)</sup> Tang et al.<sup>15)</sup> also reported that main causes of intraoperative skull fracture and EDH were the missing pressure adjusting of pin headrest, lack of an intermediary piece and calvarial thickness. The recommended clamping force for skull clamp is between 60 and 80 pounds for adult, although there exists no definite guidelines for the force level to use for the pediatric group. The 40–60 pounds of clamping force is the appropriate level of force to be applied for children younger than 15 years.<sup>16)</sup> In our case, we think that these procedure-related complications may be caused by inadvertently forceful pressure for skull fixation. Baerts et al.<sup>2)</sup> suggested several tips to avoid the complications of pin headrest, which are 1) avoid the pin headrest if it is possible; 2) use the head holder with gentle care and place pins where no major vessels are to be expected; 3) use the sealing ointment around pins sufficiently; 4) never remove the head holder unless there is no gradient between head and heart level.

Although pin-type headrest has been used widely, skull perforation and depressed fracture with EDH may be rarely developed in normal adult skulls. So, we should take care to use skull fixation devices for stereotactic or microneurosurgical procedures.

## Conclusion

We report a complicated case with depressed skull fracture and perforation by inadvertent application of skull fix-

ator for the stereotactic aspiration of ICH in adult. To avoid this disastrous complication, it should be cautious to place pins adequately and the tightening force be catered individually. We also have to consider the skull thickness and texture before skull fixation.

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