Rapid Neurological Alteration Associated with Concave Deformity of the Skin Flap in a Craniectomized Patient. Case Report

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Summary

Rapid neurological alteration was observed in association with concave deformity of the skin flap following a large decompressive craniectomy. In an erect position, hemiparesis and dysphasia showed marked deterioration with a sinking skin flap and CT-scan showed considerable distortion of the underlying brain tissue. Those changes were rapidly improved by restoration of normal curvature of the skin flap in a supine position. EEG findings coincided with such rapid alteration. Neurological changes may be due solely to concave deformity of the skin flap and the underlying brain tissue; this characteristic phenomenon might be described as “the syndrome of the sinking skin flap.” The presence of shunt system seems to play an important role in appearance of such a phenomenon.

Key words: Sinking skin flap, decompressive craniectomy, shunt operation, cranioplasty

Introduction

It has been our observation that in the presence of significant concave deformity of the skin flap following large craniectomy, progressive deterioration of neurological status will occur and that this unfavorable effect can be promptly reversed when the deformity is corrected by adequate cranioplasty. Presented here is a unique case of such a phenomenon where computerized tomography (CT-scan) and electroencephalographic (EEG) observations were made of the rapid neurological alteration related to the concave deformity of the skin flap and the underlying brain tissue during postural changes.

Case Report

A 26-year-old fireman fell from a moving fire engine and hit his unprotected head against a concrete surface on Feb. 1, 1977, and when he was brought to the emergency room, he was lethargic with dense right hemiparesis. Carotid angiography disclosed massive subdural hematoma over the left hemisphere. He was brought to the operation room immediately and a large craniotomy was made to evacuate acute subdural hematoma. The brain was swollen with considerable contusion and extensive posttraumatic edema seemed inevitable. A bone flap was removed for the purpose of decompression. The patient remained comatose over the next few weeks. During this period, the skin flap was full and tight, and repeated left carotid and right brachial retrograde angiography showed marked enlargement of the ventricular system with no midline shift, and the possibility of posterior fossa hematoma was ruled out. A ventriculoperitoneal shunt was constructed on Feb. 23, 1977. The skin flap was relaxed and began to sink to a degree of significant concavity. His level of consciousness improved remarkably and he was able to show prompt response to external stimuli. However, his dense right hemiparesis and dysphasia failed to show
reasonable improvement. On Mar. 22, 1977, a methyl methacrylate cranioplasty was made over the marked concavity of the bony defect. Postoperatively there was steady improvement in hemiparesis and speech, and at discharge from the hospital, he was able to walk without assistance and to feed himself with good use of chop-sticks in the right hand. Speech showed slow but steady improvement until Sept. 27, 1977, when he complained of intermittent dull aches over the implanted plate and gradual deterioration was noted in his neurological status. On Oct. 27, 1977, he experienced a Jacksonian seizure starting from the right hand. At this time, the skin flap was tender and swollen. CT-scan revealed fluid collection beneath the plate suggesting the presence of epidural empyema. The skin flap was turned and the plate was removed to evacuate a large amount of purulent fluid on Nov. 11, 1977. Culture showed growth of citrobactor.

The skin flap had sunken after removal of the infected plate and use of antibiotics, and at the same time his neurological status showed unexpected rapid deterioration. The first and the most prominent deterioration was in his speech, followed by further weakness of the right limbs. The wound healed well and rehabilitation was started within 2 weeks, expecting improvement of his neurological status. The most striking observation was that his motor function and speech turned unequivocally worse, with occurrence of headache and dizziness on returning from daily training in an erect position. The skin flap was remarkably concave in this situation (Fig. 1). It is noteworthy that this rapid deterioration was promptly reversed by letting him take a horizontal or Trendelenburg’s position with restoration of the curvature of the skin flap. This phenomenon was not only related to the rehabilitation activity but also the neurological changes were reproducible by alteration of the posture such as from a sitting position to a recumbent or Trendelenburg’s position, or vice versa. When he sat up and the skin flap sank, he was unable to speak a single word and a complete paralysis of the right upper extremity was elicited in a few minutes. This position was actually intolerable for him. When he returned to a horizontal position, his ability was restored. This phenomenon was reproduced during observation of CT-scan (Fig. 2). Fig. 2a shows the most marked concavity of the skin flap and the deformity of the underlying brain tissue with displacement of the ventricular system when his head was elevated. In this position, he was mute and completely paralyzed in his right upper extremity. Following this situation, CT-scan was repeated in a Trendelenburg’s position with head lowered (Fig. 2b), the deformity of the brain tissue became less remarkable, the ventricular system was filled with more cerebrospinal fluid, and the midline structure came close to the normal position. He could then speak rather fluently and individual finger motion on the right side became possible.

EEG was also recorded in a similar situation (Fig. 3). In the head elevated position, there were continuous polymorphous delta activities of high amplitude over the left frontotemporal area spreading posteriorly and to the opposite side (Fig. 3a). Soon after restoration of the curvature of the skin flap in a horizontal posi-
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Fig. 2  a: CT-scan shows marked concavity of the skin flap and distortion of the underlying brain tissue and the ventricular system when the head is elevated. b: Improvement of deformity in a Trendelenburg's position with the head lowered, accompanied with remarkable neurological improvement. Two hours from the proceeding CT-scan (Fig. 2a).

Discussion

In the presence of large sinking skin flap, deterioration or delayed improvement of neurological status may occur and the concomitant deformity of the underlying brain tissue is responsible for such a phenomenon. These unfavorable effects on cerebral function can be promptly corrected by cranioplasty. Our first observation of this unique phenomena dates back to 1969, when two episodes of characteristic neurological alteration were described in a 48-year-old college faculty member after large decompressive craniectomy for subdural hematoma.5) Since then two series of a total of 333 craniectomized patients were reviewed in search of the true incidence and nature of this phenomenon, and the responsible mechanism were discussed.7,8) In these studies, 13 among 69 patients with concave deformity of the skin
flap showed such a phenomenon and their neurological deficits were corrected by cranioplasty. Interestingly, craniectomized patients following removal of meningioma had the best prognosis with regard to their neurological status following cranioplasty. This alteration of brain function was also reflected in EEG. Improvement of EEG following correction of deformity of the skin flap was surprisingly good, as observed in as many as 12 out of 20 patients (60%). Six of them showed prompt improvement of neurological status. No objective changes were seen in patients with the full or bulging skin flap before cranioplasty. Considering that neurological deterioration is due solely to the concave deformity of the skin flap and the underlying brain tissue, this characteristic phenomena can be described as "the syndrome of the sinking skin flap." This phenomena should not be confused with the so-called "syndrome of the trephined skull" or "post-traumatic syndrome," which are mainly composed of psychic or neurotic components.

In the case reported here, rapid neurological changes due to the concave deformity of the brain were repeatedly reproduced by alteration of the patients posture. The deformity of the brain and the ventricular system, observed in successive CT-scans, and EEG findings coincided exactly with the neurological changes within a short period of postural alteration. In this case, the presence of a well-working shunt system is thought to be one of the most important factors in the mechanism which was involved in the development of such marked concave deformity in an erect position. Rapid restoration of the ventricular system by placing
the head in a lower level was presumably caused by movement of CSF into the intracranial space from the spinal compartment and also possibly by filling of the venous system of the brain.

To our knowledge, there had been no reports dealing with this characteristic phenomenon in relation to the concavity of the skin flap and the underlying brain tissue before our report in 1975. Recently there appeared a single case report by Tabaddor and LaMorgese. Their patient showed a similar clinical picture of progressive neurological deterioration following decompressive hemi-craniectomy for acute subdural hematoma. The authors claimed this to be the first such report, which prompted a short comment from us.

Two cases of Guido and Patterson, Jr. were reported soon thereafter, in which neurological deterioration was said to be due to the deformity of the brain caused by CSF leakage after lumbar puncture in craniectomized patients. The observations of Guido and Patterson, Jr. suggest a higher incidence of neurological deficits following divergence of CSF by shunt system in the presence of large bony defects. This was true in this particular patient reported by us and in a recent analysis, in which neurological improvement was seen in 43% of patients with shunt system in comparison with 29% without shunt system following cranioplasty. Grantham and Landis observed that almost every partially aphasic patient was able to use more words after cranioplasty, but they did not give any reason for this remarkable neurological improvement and made no note of the state of the skin flap. In our experience, improvement following repair of the deformity was striking not only with regard to the speech of many dysphasic patients, but also in motor function, higher cortical function of the parietal lobe, and in the visual field, according to the location of the bony defect. Gardner stressed the importance of immobilization of the brain as a beneficial effect of cranioplasty, but did not discuss the deformity of the brain beneath the concave skin flap. Gardner's interest was apparently in the presence of pulsation of the brain in the trephined skull. In the development of "the syndrome of the sinking skin flap" the role of the pulsation of the brain is not clear, as a purely objective matter, but such a marked distortion of the brain visualized by CT-scan or pneumography would be enough to explain the alteration of neurological status.

References