Intracranial pressure monitoring for special patterns of frontal lobe contusions

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【Abstract】Objective: To study the effect and indications of intracranial pressure (ICP) monitoring for frontal lobe contusion patients.

Methods: During January 2005-December 2008, 34 cases of frontal lobe contusion received ICP monitoring in our department (monitoring group). Different treatment protocols were adopted according to the results of ICP. Meanwhile 46 cases of same type of head-injured patients who did not undergo ICP monitoring served as control group.

Results: We found that ICP elevated dramatically within 24 hours after head injury if the contusions were located in frontal longitudinal dehiscence, bilateral undersurface of frontal lobe or dispersed in bilateral lobe. After half a year follow-up and on the basis of Glasgow Coma Scale assessment, the monitoring group showed better outcome than the control group with good recovery in 24 cases (70.6%), moderate disability in 7 cases (20.6%), severe disability in 2 (5.88%) and death in 1 (2.94%). The outcome of control group displayed good condition in 25 cases (54.3%), moderate disabilities in 8 (17.4%), severe disability in 7 (15.2%), and death in 6 (13.0%).

Conclusions: Frontal lobe contusions are vulnerable and complex head injuries, especially when the contusions are located in frontal longitudinal dehiscence, bilateral undersurface of frontal lobe or diffused in bilateral lobes. These patients should undergo ICP monitoring regardless of their consciousness status. If ICP elevates over 25 mm Hg, the craniotomy is mandatory and will markedly reduce the mortality and disability of these patients.

Key words: Frontal lobe; Contusions; Intracranial pressure; Craniotomy

Frontal lobe contusion often has a latent clinical manifestation but deteriorates dramatically, thus renders us a relatively short rescue time. If neurosurgeons miss the chance of intervention, its mortality and disability rates are quite high. On the basis of our five-year retrospective comparative data of ICP monitoring in patients with frontal lobe contusion and laceration, we aimed to study the effect of ICP monitoring on the diagnosis and treatment of frontal lobe contusions.

METHODS

Patients

There were 80 cases of frontal lobe contusion treated in our hospital from January 2005 to December 2008, including 59 males and 21 females, ranging in age from 13 to 74 years (38.4 years on average). The causes of injuries were motor vehicle accidents in 61 cases, falls from height in 13 and assaults or falling down in 6. The location of the injuries consisted of contusion and laceration at both frontal lobes in 33 cases including 7 cases of contusion and hematoma at longitudinal fissure, 10 cases of contusion at ventral parts of both frontal lobes and 5 cases of diffused contusion at both frontal lobes. Unilateral frontal lobe contusion and laceration in 47 cases included concurrent posterior occipital epidural hematoma in 5 cases and cerebellar contusion in 2.

Clinical manifestation

In this series, 46 patients were conscious and 34 unconscious (including 17 cases of confusion and delirium, 11 light coma and 6 coma) on admission. Sixty-six cases had normal pupillary reaction, 12 unilateral dilated pupils and 2 bilateral dilated pupils. Contraction of both pupils were found in 4 cases of hematoma at longitudinal fissure, 4 contusions at ventral part of both
frontal lobes and 3 diffused contusions at both frontal lobes.

**Therapeutic schema**

The placement of intracranial probe to monitor ICP was immediately conducted in 34 patients after hospitalization. Among them, 9 patients received craniotomy to relieve ICP immediately after the implanted probes detected ICP over 25 mm Hg, and 12 patients whose ICP were lower than 25 mm Hg were given dehydration treatment and followed by craniotomy after their ICP elevated over 25 mm Hg. Among these 12 cases, there were 4 cases of hematoma at longitudinal fissure, 4 cases of contusion at ventral part of both frontal lobes and 2 cases of diffused contusion at both frontal lobes (Figures 1-3).

Twenty-nine patients who did not receive ICP monitoring underwent craniotomy. Among them, 12 patients were operated upon immediately after hospitalization because CT images manifested extended contusion at both frontal lobes. Since these 12 cases did not undergo ICP monitoring, and surgical interventions were decided according to clinical features such as mental status, pupillary reaction and urinary incontinence and so on, as well as prompt and repeated CT examination. Seventeen patients did not receive any operation after the dehydration therapy. Whether the cranial bone was removed was dependent upon the severity of hematoma and herniation.

**RESULTS**

According to Glasgow Coma Scale (GCS) score, the comparison of outcomes between the monitoring and control group after half a year follow-up is listed in Table 1. We found that the good recovery and moderate disability rate of the monitoring group was higher than that of the control one, while the severe disability rate and mortality rate were significantly lower than those of the control one.

**DISCUSSION**

Decelerating contrecoup injury and accelerating direct-force injury onto the occiput are the two major mechanisms of frontal lobe contusion and laceration. Because of special anatomical structure and function of the frontal lobes, the contusion and laceration of the frontal lobes have minimum clinical manifestation at early stage. In some cases, the damage of the frontal lobes may be mild, but ICP is usually high and results in rapid deterioration. It is necessary to undergo ICP monitoring early to avoid detrimental high ICP and to lower mortality rate.\(^1\)\(^2\)

ICP monitoring is an objective and stable parameter reflecting frontal lobe contusion and laceration. By
monitoring ICP, we would determine whether or when to perform surgical intervention. The indication for ICP monitoring usually include all frontal lobe contusion and laceration. In the monitoring group, 34 case received ICP monitoring, in whom, 12 cases underwent craniotomy after ICP monitoring, indicating that ICP elevation appears earlier than clinical signs and pupil reactions. Among the 12 cases, contusions were located at longitudinal fissure in 4 cases, at ventral part of both frontal lobes in 4 cases, and diffused contusions at both frontal lobes in 2 cases, accounting for 83% of the 12 cases. In the 17 cases who received craniotomy before ICP monitoring, 12 (71%) had frontal lobe contusion and laceration, especially at longitudinal fissure or ventral part. They predisposed to ICP elevation as a result of cerebral edema. Also, the anatomical structure of the frontal lobe is different from that of the temporal lobe. When the focal ICP elevates, it will compress the brainstem due to downward pressure gradient and cause the central transtentorial herniation of the brain.

In this series, the development and aggravation of brain edema are due to several reasons. Firstly, blood vessels at internal sides of frontal lobes are compressed by falx cerebri. If the anastomotic veins are compressed, the venous drainage of two frontal lobes will be completely blocked. Secondly, when the lateral cerebral fissures are injured, the middle cerebral artery and vein are damaged. As a result, the infarction plus drainage block by the middle cerebral vein damage causes severe cerebral edema. Thirdly, the sedimentation of deep brain structure by frontal contusion and laceration will lead to brain deep venous obstruction. Severe cerebral edema or cerebral hematoma will in turn elevate ICP and hamper the venous drainage. Lower cerebral perfusion pressure will at last worsen cerebral edema. Such vicious cycle will cause and accelerate irreversible brain central herniation. After ICP elevates to a threshold, the direct compression on the brainstem induces the imminent central circulation and respiratory failure, thus causes the sudden death of the patient. We therefore should put great emphasis on the small hematoma and contusion at longitudinal fissure, contusion at ventral part of both frontal lobes and diffused contusion at both frontal lobes. ICP monitoring should be instituted and if ICP is over 25 mm Hg, surgical intervention is mandatory.

Although the clinical manifestations of brain central herniation are insidious, its progress is rapid. During diencephalon period, the patient is conscious, two pupils contract, the breath rhythm will change and pathological reaction presents positive. This period is the critical period for the therapy. When the frontal lobe injuries present typical diencephalon period manifestations, the better choice for the therapy is large dose of dehydration and craniotomy when necessary. The early treatment will prevent deterioration of patients’ condition and improve the recovery rate. If patients are treated inappropriately, subsequent deterioration is inevitable, the mental status turn to deep coma. When GCS score decreases dramatically, the patient’s pupils dilate, light reflexs disappear, circulatory and respiratory failure presents, then the death is imminent.

The earlier the surgical intervention is, the better the patients’ outcome would be. Regarding the indication for the surgical intervention, we believe the volume of the hematomas and the shift of midline are an important but not sole guideline. The indications for the surgical intervention are considered as follows: (1) the volume of frontal lobe hematoma is larger than 25 ml at the early stage of hospitalization; (2) the midline shift is over 1 cm for unilateral frontal lobe contusion and laceration; (3) ICP is continuously over 25 mm Hg, while dehydration therapy proves to be ineffective; (4) continuous head CT examinations show that the secondary hematoma appears or cerebral edema becomes extended; the anterior horn of the lateral ventricle is compressed by elevated ICP and basal cistern is obscure; (5) there are clinical manifestations of diencephalon period of the brain central herniation such as the contraction of the pupils, changes of the breath rhythm and positive pathological reaction.

In conclusion, if the indication for surgical intervention is obvious, surgical intervention should be performed immediately. If there are no indications for craniotomy after hospitalization but with frontal lobe contusions at longitudinal fissure, at ventral part of both frontal lobes or diffused contusions at both frontal lobes, ICP monitoring and close observation on consciousness, pupillary reaction, respiration changes, and CT images are mandatory. Appropriate dehydration therapy should be administered during this period. Once the patients’ condition is deteriorated, surgical intervention is an optimal option.
REFERENCES


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