Neurosurgical Technique **Decompressive craniectomy for massive cerebral infarction with enlarged cruciate duraplasty**

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Summary

The use of decompressive craniectomy for massive cerebral infarction is attracting renewed interest because conventional medical treatment is associated with high mortality. The technique of duraplasty may be important. We have developed a 4 step volume-enlarged cruciate duraplasty and report its use in 12 patients with massive cerebral infarction. None of the patients needed an additional anterior temporal lobectomy to reduce intraoperative intracranial pressure and none suffered epilepsy after the operation. This initial experience suggests that the use of a stepwise cruciate duraplasty during a decompression may promote clinical outcomes and further evaluation is merited.

Keywords: Decompressive craniectomy; cerebral infarction; middle cerebral artery (MCA); duraplasty.

Introduction

Massive cerebral infarction involving the entire middle cerebral artery (MCA) territory occurs in 10-15% of patients with a supratentorial stroke cases and is associated with severe brain swelling and death resulting from brain herniation [2, 4]. The mortality (approaching 80%) associated with conventional medical treatment, has led to renewed interest in the use of decompressive craniec-

tomy [3, 6-8] and a previous report from our group suggested that it might decrease mortality [9].

The techniques of the operation, such as the diameter of bone flap and dural incision, have been considered in previous reports. Less consideration has yet been given to the details of duraplasty. We describe a volume-enlarged cruciate duraplasty aimed to achieve a stepwise symmetrical decompressive effect, to increase cerebral compliance, and to avoid epilepsy caused by scar formation between the cortex and epidural tissues and describe the initial experience of its use in 12 patients. The research protocol was approved by the hospital's medical ethics committee.

Technique

A 6×8 cm piece of artificial dura is divided into four parts, as illustrated in Fig. 1a. After the bone flap was removed, the dura is opened by a small straight incision in a central location. A narrow brain retractor is then passed under the dura and a vertical dural incision was made on one side of the previous incision up to the edge of the craniectomy. The first part of dural patch is placed quickly into this incision in order to obtain initial decompression (as shown in Fig. 1b). The processes are repeated in the opposite direction to allow further volume-enlargement of the swollen hemisphere. Then the other two parts of the patches are respectively placed into dural incisions to form the stepwise volume-enlarged cruciate duraplasty that allows the brain to herniate outward in a more controlled manner. The eventual

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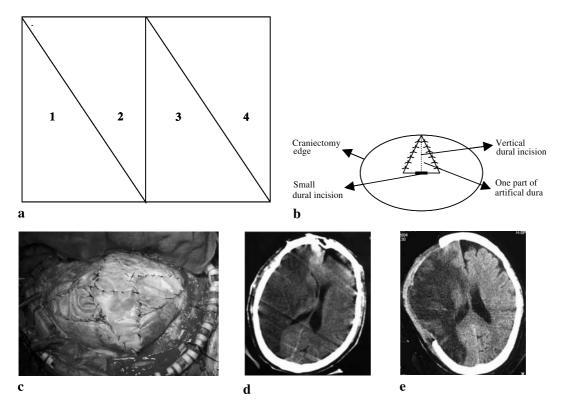


Fig. 1. (a) A $6 \text{ cm} \times 8 \text{ cm}$ artificial dura was divided into four parts. (b) The dura was opened by a small straight incision in a central location. A vertical dural incision was then made on one side of the previous incision till craniectomy edge. The first part of dural patch was placed into this incision quickly in order to obtain initiatory decompression. (c) Enlarged cruciate duraplasty for massive cerebral infarction in practice. (d) Head CT scan showing massive cerebral infarction with malignant brain swelling. (e) Post-operation CT scan

cruciate duraplasty involves the frontal, parietal, temporal, and parts of the occipital lobes.

Illustrative cases and the initial experience

Figure 1c is an operative photograph of an enlarged duraplasty. The patient was a 64-year-old male whose computed tomography (CT) fulfilled the following criteria: loss of the corticomedullary contrast or a hypodense area of more than 50% of the middle cerebral artery territory, massive brain swelling with a midline shift of 5 mm or more (as shown in Fig. 1d). The patient had first been treated using standardized conservative management. Decompressive craniectomy with enlarged cruciate duraplasty was performed, after significant neurological deterioration occurred. After the operation he gradually recovered and was able to obey commands 7 days after the onset of the stroke. A post-operative CT scan is shown in Fig. 1e.

We have used this technique of duraplasty in 12 patients. None needed subsequent anterior temporal lobectomy to reduce intraoperative intracranial pressure and none developed epilepsy. Clearly, during decom-

pressive craniectomy, other approaches for the control of intra-cranial hypertension should also be used, such as brief hyperventilation, administration of mannitol, and consideration of bolus doses of barbiturates.

Discussion

The concept that decompressive craniectomy can provide a clear survival benefit for patients who have hemispheric brain swelling caused by trauma and infarction [3, 5-9] is supported by a recent pooled analysis of three randomised controlled clinical trials. This showed that decompressive surgery undertaken within 48 h of stroke onset reduced mortality and increased the number of patients with a favourable functional outcome [10]. When decompression is used on a head injured patient, surgeons often use slit-like or reversed U-shaped incision to open dura [1]. With these kind of durotomies, any subdural heamatoma is easily removed - leading to control of increased intracranial pressure. However, if the dura is not opened sufficiently and widely, the brain can protrude through the dural window and infarcts further.

The key of the craniectomy for massive cerebral infarction with hemispheric brain swelling is to achieve an adequate decompressive effect. In addition to a large and low craniotomy, the opening of the dura and the duraplasty are also very important because the former can further reduce intracranial pressure (ICP) [11] while the latter can enlarge the intradural space which is beneficial to swollen infarcted tissues [10].

We describe the stepwise enlarged cruciate duraplasty. This takes full advantage of a large craniotomy and provides sufficient and symmetric extension for protrusion of the infarcted brain and reduces the risk of additional lesions, such as focal cortical ischaemia and hemorrhage caused by shear forces at the edges of the dural asymmetric incision. Complete dural repair may help to prevent epilepsy caused by the scar formation between the cortex and epidural tissues.

Performance of the duraplasty in a stepwise mode, ensuring that every incision and repair is performed one by one, reduces the chances of intra-operative brain swelling. This four-step duraplasty may also prevent surgical complications such as excess deleterious brain shift and haematomas casued by sudden pressure reduction of hemisphere. From our experience, in none of these patients, has it proved to be impossible to obtain cranial closure. In conclusion, our study describes a new stepwise cruciate duraplasty which may lead to better clinical outcomes during decompression for massive cerebral infarction. Further evolution is warranted.

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Comment

This is a technical report describing a new approach to perform duraplasty in patients undergoing decompressive craniectomy for malignant MCA infarction. In a stepwise fashion the dura is incised and then a dural patch is used to enlarge the dural surface. The technique is nicely illustrated. The authors have used this modification in 12 patients with good results.

I believe that this represents a useful modification.

P. Schmiedek Mannheim