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THE EFFICACY OF DECOMPRESSIVE CRANIECTOMY IN TREATMENT OF PATIENTS WITH MASSIVE HEMISPHERIC CEREBRAL INFARCTION

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ABSTRACT

Massive cerebral infarction is often accompanied by early death, secondary to brain edema and trans-tentorial herniation. Several reports indicate beneficial effects of decompressive craniectomy in this situation, but the efficacy of this procedure is still a matter of debate.

An experimental study in a period of 3 years was done on 23 patients with brain edema due to massive cerebral infarction; 11 patients were subjects and were operated, and 12 were in the non-operated group who only underwent conservative treatment. All patients in this study had GCS below 8.

The mean age of the operated patients was 54.5 years and for the unoperated patients 64.4 years. Mean GCS in the operated cases was 7.00 and in the unoperated cases was 7.66. In the operated group 4 of 11 patients lived (36.4%) and in the unoperated group 1 of 12 cases lived (8.3%). In the living operated cases, 1 had GOS 4 and 3 cases had GOS 3. In unoperated cases 1 patient lived that had a GOS of 2.

These results show that decompressive craniectomy can be an effective lifesaving procedure for malignant brain edema after cerebral infarction and can also give acceptable functional recovery.

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INTRODUCTION

Ischemic cerebrovascular disease is the most prevalent brain disease, and also the most common cause of death among such diseases.[13] During the acute period following a cerebral infarction, current medical management is primarily supportive to prevent the extension of the infarction or development of cardiopulmonary complications.[3]

Despite the advances, there is still a subset of patients who deteriorate after hospital admission for cerebral infarction, with mortality approaching up to 80% when treated conservatively.[1,18,20] This occurs because acute cerebral ischemia results in a cascade of events beginning with a breakdown of the blood brain barrier and leading to secondary cerebral edema, raised intracranial pressure (ICP), herniation, coma, and death.[10] For patients who continue to deteriorate despite hyperventilation and administration of mannitol or other agents, emergency craniectomy may be indicated.[13] In this article, we examined the role of decompressive craniectomy in 23 patients with GCS less than 8, of whom 11 were subjects and received conservative and surgical treatment and 12 cases were in the non-operated group that received only conservative treatment. We have also reviewed the present knowledge in the literature concerning the benefits of this surgical procedure.

MATERIAL AND METHODS

This research was done experimentally in a 3 year period (1998-2001). The patients were ones with ischemic stroke admitted in the neurological service, in the event of neurological deterioration and radiological evidence of cerebral edema secondary to infarct, and the neurosurgical service was consulted for further management. The selection of patients for our study was based on clinical and radiological criteria.

Clinical signs include decreased level of consciousness, occurrence of mydriasis and aggravation of hemiparesis. CT scan criteria were malignant brain edema with midline shift and trans-tentorial herniation signs, including compression of basal cisterns (crural, ambian or suprasellar).

If each of the patient's clinical signs and CT scan findings matched the evidence of edema and herniation, the patient entered our study, unless he/she had an overwhelming medical contraindication to surgery, such as severe cardiac disease, uncontrolled hypertension, anticoagulation therapy, or terminal malignancy.

Totally 23 patients arrived in our study. 11 were in the operated group and 12 were in the unoperated group (the unoperated group contained patients whose relatives didn't accept an operation or the surgeon didn't believe in the success of the operation). The level of consciousness of all patients was in the range of GCS 5-8.

After admission, these patients were mananged in the neurosurgical care unit under the observation of a neurosurgeon and neurologist, with use of mechanical ventilation, sedation, paralysis and mannitol infusion. The 11 patients of the operated group underwent emergency decompressive craniectomy in the operation room, in addition to the above treatment.

Serial CT scan was used for evaluation of infarction. When there was evidence of clinical improvement the patient was gradually weaned off the ventilator.

Outcome was assessed based on Glasgow outcome scale (GOS). Good recovery GOS=5, moderate disability GOS=4, severe disability GOS=3, vegetative state GOS=2, and death GOS=1.[11]

The time for evaluation of availability, death and GOS was 3 months after admission. After termination of the study, the findings were analysed statistically based on Fisher exact test and chi-square test (χ^2).

Surgical technique

The technique for decompressive surgery was a large bone flap with an area of 7×10 cm (including the frontal, parietal, temporal, and part of the occipital squama) to be removed so that the floor of the middle cerebral fossa could be explored.[3]

The dura was fixed at the edge of the craniotomy to prevent epidural bleeding. The dura was opened and

Table I. Frequency distribution of sex in operated and un-operated patients.

Sex	Operated patients		Un-operated patients		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Male	9	81.8	5	41.7	15	62.5
Female	2	18.2	7	58.3	9	37.5
Total	11	100	12	100	24	100

Table II. Frequency distribution of GCS at admission in operated and un-operated patients.

GCS at Admission	Operated patients		Un-operated patients	
	Frequency	Percent	Frequency	Percent
5	2	18.2	0	0
6	2	18.2	0	0
7	1	9.1	4	33.3
8	6	54.5	8	66.7
Total	11	100	12	100

adjusted, and a dural patch made of homologous temporal fascia or fascia lata was placed in to the incision. The size of the dural patch varied, but we usually used patches 5×10 cm in length and 3.5 to 5 cm in width.[20]

RESULTS

Over a 3-year period from 1998 to 2001, there were 23 patients under our study (14 male and 9 female) (Table I) with a mean age of 59.7 years (range 38-80 years). 11 out of these 23 patients were operated and the remaining 12 patients only received medical therapy.

Operated group

The average age of the operated patients was 54.5 years, S.D±12.9 years, nine of them were male and 2 were female (Table I).

The GCS was as follows: 5 in 2 cases, 6 in 2 cases, 7 in 1 case, and 8 in 6 cases (mean=7).

Six cases had right side and 5 cases left side infarctions (Table II). Infarction territory for 10 cases was MCA, and for 1 case ACA and MCA (Table III). The average duration of hospitalization for the operated patients was 27.2 days, S.D±28.4 days. Seven of these patients died after the operations, and 4 lived through (Table IV). Three of the surviving patients had a GOS=3 and one had GOS=4, three months after operation.

Un-operated group

The patients who only received medical therapy were 12 cases. The average age in this group was 64.4 years, S.D±10.3 years, 5 were male and 7 were female (Table I). The GCS on admission was 7 in 4 cases and 8 in 8 cases (mean=7.66).

Five had right side infarction and 7 had left side infarction (Table II). The infarction territory was MCA in 10 cases and both ACA and MCA in 2 cases (Table III). The average duration of hospitalization was 8.3 days, S.D±4.2 days.

11 out of 12 cases died and 1 survived and lived vegetatively (Table IV). This patient also died after 6 months because of pneumonia.

The rate of death was 63.6% in the operated group and 91.7% in the unoperated group (Table IV), and Fisher exact test showed no significant difference between them.

In the operated group, we divided the patients into two age groups: 1- below 60 years of age, 2- 60 years of age and above. 6 patients were in the first age group, 3 of whom lived and 5 cases were in the second group and one of them lived. Statistically, there was no significant relationship between death rate and age, infarction side, initial GCS or mydriasis based on the chi-square test (χ^2).

Two out of four living patients suffered from hydrocephalus and underwent VP shunt operation.

DISCUSSION

Decompressive craniectomy was first described by Kocher in 1901 for the treatment of post-traumatic brain edema that was refractory to medical therapy. This procedure has been practiced mainly in European centers with improved mortality rates and functional outcome.[6,15] However, in the setting of cerebral ischemia, the indications are more uncertain, although it is clear that even with the best conservative therapy, the mortality rates are approximately 80%.[1,7,8,18,22] Although experimental studies in rat models of cerebral hemispheric infarctions

Table III. Frequency distribution of infarction territory in operated and un-operated patients.

Infarction Territory	Operated patients		Un-operated patients	
	Frequency	Percent	Frequency	Percent
MCA	10	90.9	10	83.3
MCA and ACA	1	9.1	2	16.7
Total	11	100	12	100

Table IV. Frequency distribution of death in operated and un-operated groups.

Status	Operated patients		Un-operated patients	
	Frequency	Percent	Frequency	Percent
Dead	7	63.6	11	91.7
Alive	4	36.4	1	8.3
Total	11	100	12	100

Table (A): Characteristics of operated patients.

Number of Case	Age	Sex	GCS at admission	Infarct side	Hospitalization (day)	GOS 3 months
1	42	M	8	Rt	56	3
2	38	M	6	Lt	4	Died
3	40	M	8	Rt	11	4
4	59	M	8	Rt	25	Died
5	60	M	6	Lt	7	Died
6	48	M	8	Rt	91	3
7	73	M	8	Rt	53	Died
8	60	F	8	Lt	10	Died
9	60	M	5	Lt	35	3
10	44	F	5	Rt	4	Died
11	75	M	7	Lt	4	Died

M, male ; F, Female ; Rt, Right ; Lt, Left ; GCS, Glasgow come scale; GOS, Glasgow outcome scale

Table (B): Characteristics of un-operated patients.

Number of Case	Age	Sex	GCS at admission	Infarct side	Hospitalization (day)	GOS 3 months
1	63	M	8	Lt	18	Died
2	72	M	8	Lt	4	Died
3	62	F	7	Lt	10	Died
4	53	M	8	Rt	4	Died
5	78	F	8	Rt	15	2
6	68	F	8	Rt	4	Died
7	75	F	8	Lt	3	Died
8	80	F	7	Rt	10	Died
9	53	M	8	Lt	7	Died
10	49	F	8	Lt	9	Died
11	57	F	7	Rt	7	Died
12	63	M	7	Lt	9	Died

M,male ; F, Female ; Rt, Right ; Lt, Left ; GCS, Glasgow come scale; GOS, Glasgow outcome scale.

have shown benefits of surgical decompression, in terms of reducing interacranial pressure and improving survival, there are relatively few clinical studies concerning the procedure.[4,5] In the literature to date, there are a few series and one case report describing the results of surgical decompression in patients with hemispheric infarction.[2,9,14,16,17,19,20,21]

Despite these relatively low numbers, the data has highlighted certain key points.

- Firstly, the reduction of mortality from 80% in conservative treated patients to between 20-35% in surgically treated patients is demonstrated.[2,14,19,20]

Schwab has reported that 73% of his patients survived (mortality rate 27%). Koh has also reported that 80% of his patients survived (mortality rate 20%), whereas Sasaki and Barter have reported mortality rates of 33% and 0%, respectively.[2,19,20]

In our study, the mortality rate is 63.3% for the operated group and 91.7% for the unoperated group with attention to this fact that all our patients had GCS below 8, and the prognosis in these patients is poor.

In our study the mean age of operated patients was 54.5, versus 64.4 in the unoperated cases. On the other hand the mean GCS in operated cases was 7.00 versus 7.66 in unoperated cases.There was no statistical difference between the age and GCS in the two groups (operated and non-operated).

In general, the response to decompressive craniectomy was better in younger patients, although no significant statistical correlation was found.

- Secondly, survival benefit is meaningless if functional outcome is poor. Although Sasaki reported that 67% of his patients had poor outcome (severe disability or vegetative state), Schwab showed that severe handicap was present in only 13% and Carter who limited his series only to patients with non-dominant hemispheric infarct had a favorable outcome in 72% of patients at 1 year (mild to moderate assistance at home and Barthel score greater than 60).[2] In our series, functional outcome in living operated patients after 3 months of admission was: 3 cases severe disability, 1 case moderate disability and in un-operated patients one lived that was in a vegetative state. In follow up 1.5-2 years in the operated group, 1 case had GOS=5, 1 case had GOS=4 and 2 cases had GOS=3 (50% favorable and 50% unfavorable).

CONCLUSION

Our results suggest that decompressive craniectomy for cerebral ischemia reduces mortality, and can also give acceptable functional recovery, especially in younger patients. By performing decompressive craniectomy, the neurosurgeon will play a role in the management of stroke patients that deteriorate due to cerebral edema.

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