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Large Defect May Cause Infectious Complications in Cranioplasty

Objective : Cranioplasty is necessary to repair the cranial defect, produced either by decompressive craniectomy or removal of the contaminated depressed skull fracture. Complications are relatively common after cranioplasty, being reported up to 23.6%. We examined the incidence and risk factors of infectious complications after cranioplasty during last 6 year period.

Methods : From January 2000 to December 2005, 107 cranioplasties were performed in our institution. The infectious complications occurred in 17 cases that required the removal of the bone flap. We examined the age of the patients, causes of the skull defect, timing of the cranioplasty, the size of the defect, and kinds of the cranioplasty material. The size of the skull defect was calculated by a formula, $3.14 \times \text{long axis} \times \text{short axis}$. The cranioplasty material was autogenous bone kept in a freezer in 74 patients, and polymethylmetacrylate in 33 patients. Statistical significance was tested using the chi-square test.

Results : The infection occurred in 17 patients in 107 cranioplasties (15.9%). It occurred in 2 of 29 cases of less than 75 cm² defect (6.9%), and 6 in 54 cases of 75~125 cm² defect (11.1%). Also, it occurred in 9 of 24 cases of more than 125 cm² defect (37.5%). This difference was statistically significant ($p < 0.01$).

Conclusion : During the cranioplasty, special attention is required when the skull defect is large since the infection tends to occur more commonly.

KEY WORDS : Surgical Flap · Infection · Craniocerebral trauma.

INTRODUCTION

Cranioplasty is the surgical correction of skull defects to protect the brain, to normalize intracranial pressure relationships alleviating neurologic signs resulting from cranial bony defects, and to provide reasonable cosmetic result^{3,7,12-14}. Complications are relatively common after cranioplasty, being reported up to 23.6%⁹. Infection and resorption are two common complications and both complications are theoretically more common when the defects are large. We examined our cases the incidence and risk factors of infectious complications after cranioplasty during 6-year period.

MATERIALS AND METHODS

From January 2000 to December 2005, we performed 107 cranioplasties. The infectious complications occurred in 17 cases (15.9%) that require the removal of the bone flap (Table 1). Infection was defined as any purulent discharge from the surgical wound to remove the bone flap. We excluded cases with small stitch abscesses, when the wound was healed without removal of the bone flap.

We examined the age of the patients, causes of the skull defect, timing of the cranioplasty, the size of the defect, and kinds of the cranioplasty material. According to the age, 29 patients were young (less than 30 years of age), 59 patients were middle aged (30-60 years of age), and 19 patients were old (more than 60 years of age). Timing, the interval from craniectomy to cranioplasty, was within 2 months in 40 patients, between 2 to 6 months in 38 patients, between 6 to 12 months in 14 patients, and after 1 year in 15 patients. The size of the skull defect was calculated by a formula, $3.14 \times \text{long axis} \times \text{short axis}$. The size was small (less than 75 cm²) in 29 cases, moderate (75-125 cm²) in 54 cases, and large (more than 125 cm²) in 24 cases. The cranioplasty material was autogenous bone kept in a freezer in 74 patients, and polymethylmetacrylate (PMMA) in 33 patients. The cause of craniectomy was trauma in 78 patients and stroke in 29 patients. Statistical significance was tested using the chi-square test and Fisher's test. A p value less than 0.05 was considered significant.

- Received : April 6, 2007
- Accepted : July 13, 2007
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Table 1. Summary of the infected cases after cranioplasty

Case No.	Age (yrs)	Sex	Size (cm ²)	Cause	Timing (month)	Material
1	21	M	150.7	SDH	2	autograft
2	28	F	129.5	SDH	7	autograft
3	28	M	55.0	SDH	2	autograft
4	29	M	141.3	SDH	3	autograft
5	30	M	96.9	EDH	2	PMMA
6	35	M	125.6	infarct	2	autograft
7	36	M	90.1	SDH	1	autograft
8	40	M	141.3	SDH	2	autograft
9	41	M	138.2	TICH	12	PMMA
10	41	M	138.2	TICH	8	autograft
11	42	M	117.8	SICH	3	autograft
12	46	M	125.6	SDH	3	autograft
13	50	M	150.7	SDH	0	PMMA
14	50	M	103.6	EDH	12	PMMA
15	56	F	40.8	EDH	6	autograft
16	59	M	76.5	SDH	3	autograft
17	70	F	77.7	infarct	3	autograft

PMMA : polymethylmetacrylate, EDH : epidural hematoma, SDH : subdural hematoma, TICH : traumatic intracerebral hematoma, SICH : spontaneous intracerebral hemorrhage

RESULTS

Age and sex

The infection occurred in 14 of 70 male (20.0%) patients, while it occurred in 3 of 37 female (8.1%). However, this difference was statistically not significant.

According to the age, the infection rate was 5.3% in the old, while it was 18.6% in the middle (Table 2). However, this difference was statistically not significant.

Size of the defect

The average size of the skull defect was 112. 8 cm² in cerebral infarction, 105.0 cm² in acute subdural hematoma, 95.5 cm² in traumatic intracerebral hemorrhage, 86.5 cm² in epidural hematoma, and 77.7 cm² in spontaneous intracerebral hemorrhage.

The infection was more common when the defect was large. It occurred in 2 of 29 cases of less than 75 cm² defect (6.9%), and 6 in 54 cases of 75~125 cm² defect (11.1%). It occurred in 9 of 24 cases of more than 125 cm² defect (37.5%). This difference was statistically significant (p<0.01).

Timing and materials of the cranioplasty

The cranioplasty was performed within 2 months in 40 patients (37.4%), between 2 to 6 months in 38 patients (35.5%), between 6 to 12 months in 14 patients (13.1%), and after 1 year in 15 patients (14.0%). The infection rate was the highest (21.4%) when the operation was performed

Table 2. Risk factors of infectious complications after cranioplasty

Variables	Infection(-)	Infection(+)	Stat. Sig.
Age(yrs)			p > 0.05
	0 ~ 30	24	5
	30 ~ 60	48	11
	over 60	18	1
Sex			p > 0.05
	male	56	14
	female	34	3
Defect size			p < 0.05
	75 cm ²	27	2
	75~125 cm ²	48	6
	over 125	15	9
Timing(months)			p > 0.05
	within 2	33	7
	2 ~ 6	33	5
	6 ~ 12	11	3
	over 12	13	2
Material			p > 0.05
	PMMA	29	4
	Autograft	61	13
Causes			p > 0.05
	EDH	15	3
	SDH	25	9
	TICH	24	2
	Infarct	7	2
	SICH	19	1
Total	90	17	

Stat. Sig. : statistical significance, PMMA : polymethylmetacrylate, EDH : epidural hematoma, SDH : subdural hematoma, TICH : traumatic intracerebral hematoma, SICH : spontaneous intracerebral hemorrhage

between 6 to 12 months. However, this difference was statistically not significant.

The cranioplasty material was frozen autogenous bone in 74 patients (69.2%), and PMMA in 33 patients (30.8%). The infection rate was 17.6% in autogenous bone, while it was 12.1% in PMMA. However, this difference was statistically not significant.

Causes of skull defect

The cause of craniectomy was trauma in 78 patients (72.9%) and stroke in 29 patients (27.1%). The infection rate was relatively high in the acute subdural hematomas (26.5%, 9 in 34) and the cerebral infarct (22.2%, 2 in 9). The overall infection rate was 17.9% in trauma, and 10.3% in stroke. However, these differences were statistically not significant.

DISCUSSION

The infectious complications occurred in 17 cases (15.9%) that required the removal of the bone flap. The range of

infection in clean neurosurgical operations in randomized controlled trials is 4.0% to 12.0% without prophylactic antibiotics and 0.3% to 3.0% with prophylactic antibiotics⁴. Currently, an incidence of infectious complications less than 5% is considered acceptable⁵.

The infection rate of cranioplasty depends on several factors; age, material, site and size of the defect, and others^{1,8,9}.

The incidence of late complications in pediatric population was reported as high as 23%¹¹. It was related to the thinner scalp, continued skull growth and greater activity level of the child¹¹. However, the age was not a significant risk factor in the adult population⁸. The infection rate of the aged group was not significantly different from those of the other groups in this study.

The infection rate was 21.4%, when the operation was performed between 6 to 12 months. Matsuno et al.⁸ reported that one of the statistically significant risk factors for the infection was timing of the cranioplasty. The mean time intervals of the infected group were longer than that of the uninfected group. As the cause of their high infection rate, they questioned their method of storage; 100% ethanol at -20°C. We stored them in -70°C, and there was no statistically significant difference with regards to the timing.

A variety of materials are used for the cranioplasty. Bone autograft and alloplasts are most commonly used at the present time⁹. Although the autogenous bone remains the preferred option, infection and graft absorption are common complications of the cranioplasty using frozen autogenous bone graft^{8,9}. The infection rate of the autogenous bone graft was reported as 0-33%^{2,6,9,10}. PMMA is the most frequently used alloplastic material⁹. The infection rate is rather lower than the autogenous bone graft, being reported as 1-16%^{11,15}. In this study, the infection rate was 17.6% in autogenous bone, while it was 12.1% in PMMA.

The size of the defect may influence on the infection rate¹¹. The average size of the defect was 95.1 cm² (SD 33.6 cm²). We defined the small defect as the size of less than 75 cm² and the large defect as the size of more than 125 cm². The infection rate was 6.9% in small defect, 11.1% in middle defect, and 37.5% in large defect. The size was the only difference reached to the statistical significance ($p < 0.01$) in this study. When the defect was large, the size of the scalp flap would be large to cause insufficient blood supply to the end of the flap. When the skull defect was very large, more careful approach to enhance the blood supply to the scalp flap seems to be necessary.

The risk factors of the cranioplasty infection may differ according to the authors and patients populations. Besides those factors, there were some more predisposing factors such

as the site of defect, prior infection, number of procedures, and postoperative radiation therapy. When the skull defect is close to the paranasal sinuses, the infection rate would increase^{1,9}. There were no statistically significant differences in the age, sex, cause of the defect, operation time, surgeon, and antibiotics prophylaxis.

CONCLUSION

During the cranioplasty, special attention is required when the skull defect is large since the infection tends to occur more commonly.

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