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Review

Malignant cerebral swelling following cranioplasty

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ABSTRACT

Over the past few years there have been a number of case reports and small cohort studies that have described so called "malignant" cerebral swelling following an uneventful cranioplasty procedure. The pathophysiology remains to be established however it has been suggested that it may be related to a combination of failure of autoregulation and the use of closed vacuum suction drainage. The current study presents three further patients who had had a decompressive hemicraniectomy for ischaemic stroke. If decompressive craniectomy is utilised in the management of neurological emergencies, close attention and wider reporting of this type of complication is required not only to focus attention on possible management strategies, but also to determine which patients are at most risk of this devastating complication.

1. Introduction

There continues to be considerable interest in the use of decompressive craniectomy in the management of neurological emergencies [1]. Once the cerebral swelling has subsided a cranioplasty is required in order to restore cosmesis and cerebral protection. Technically this is a very simple surgical procedure, however it is becoming increasingly apparent that it can be associated with significant complications [2–5].

Until recently one complication that has received relatively little attention is that of massive so called "malignant" cerebral swelling following an uneventful cranioplasty procedure [6]. However over recent years there have been a number of case reports and cohort studies describing this phenomenon [7–16]. At the two public hospitals providing neurosurgical services in Western Australia, three deaths following cranioplasty were initially reported in 2011 [6]. All three deaths occurred in young men who had had a surgical decompression following severe traumatic brain injury. There have since been three further cases each of which was in the context of cranioplasty for patients who had had a decompressive hemicraniectomy for "malignant" middle cerebral infarction.

The aim of this review is to report these cases and to review the literature in order to determine the incidence of this devastating complication. In addition we aimed to establish whether there had been further cases at either of the two public hospitals in Western Australia that provide neurosurgical services.

2. Method

A literature search was performed in the MEDLINE database (1966 to June 2015). The following keywords were used: "hemi craniectomy", "decompressive craniectomy", "cranioplasty", "complications", "sudden death", "middle cerebral infarct" and "traumatic brain injury". The bibliographies of retrieved reports were searched for additional references. Studies that were published only in abstract form and non-English language studies were excluded. Specific care was taken to describe the clinical indications for the initial decompressive surgery and timing of cranioplasty.

In addition, the statewide neurosurgical database that centrally stores information regarding all surgical procedures performed at the two adult hospitals in Western Australia was accessed. A search was performed using the following keywords: "craniectomy", and "cranioplasty". The database records 30 day mortality. It was therefore possible to cross reference any cases of death following these procedures.

3. Results

Overall, including the current study, there have been 19 cases of massive cerebral swelling resulting in death following an uncomplicated cranioplasty procedure to our knowledge [6–16] (Table 1).

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Table 1
Characteristics of patients in studies reported in the literature

Authors, year Study type (incidence)	Patient age, years (sex)	Primary pathology	Timing/Type of cranioplasty	Preop neurological condition	VP shunt	Cranioplasty material	Postop drain	Postop seizure	Maximal cerebral swelling in relation to side of craniectomy
Van Roost et al., 2003 [7]	32 (M)	TBI	NS	NS	NS	NS	Yes	Yes	NS
Case report									
Eom et al., 2010 [8]	6 (M)	Ischaemic stroke	9 months/Right	NS	No	Autologous	Yes	Yes	Contralateral hemisphere
Case report									
Honeybul, 2011 [6]	22 (M)	TBI	88 days/Bifrontal	Dependent	Yes	Autologous	CVSD	Yes	Bilateral hemispheres
Cohort study (2.2%)	16 (M)	TBI	70 days/Bifrontal	Dependent	Yes – ligated at surgery	Autologous	CVSD	No	Bilateral hemispheres
	16 (M)	TBI	80 days/Bifrontal	Dependent	Yes – ligated at surgery	Autologous	CVSD	No	Bilateral hemispheres
Zebian & Critchley, 2011 [9]	40 (F)	Ischaemic stroke/SAH	2 years/Left	Dependent	Yes	Titanium	CVSD	Yes	Contralateral hemisphere
Case report									
Santana-Cabrera., 2012 [10]	17 (M)	TBI	2 months/ Bifrontal	Independent	No	Autologous	NS	No	Bilateral hemispheres
Case report									
Chitale et al., 2013 [11]	64 (M)	Ischaemic stroke	12 months/Right	NS	No	PEEK	NS	Yes	Bilateral hemispheres
Case report									
Broughton et al., 2014 [12]	NS	NS	NS	NS	NS	NS	CVSD	No	NS
Cohort study (2.3%)									
Sviri, 2015 [13]	22 (M)	TBI	9 months/Right	Mild dependence	No	Autologous	CVSD	No	Contralateral hemisphere
Cohort study (7%)	14 (M)	TBI	10 months/Left	Dependent	No	Autologous	CVSD	No	Contralateral hemisphere
	28 (M)	TBI	17 months/Right	Independent	LP shunt	Methylmethacrylate	CVSD	No	Contralateral hemisphere
	24 (M)	TBI	3 months/Left	Dependent	No	Autologous	CVSD	No	Contralateral hemisphere
Lee et al., 2015 [14]	50 (F)	SAH	61 days/Right	NS	No	Autologous	CVSD	Yes	Ipsilateral hemisphere
Case report									
Mangubat & Sani, 2015[15]	14 (F)	TBI	83 days/Left	Dependent	Yes	PEEK	NS	No	Bilateral hemispheres
Case report									
Hassaneen et al., 2015[16]	50 (F)	Ischaemic stroke	4 months/Right	Dependent	No	Autologous	NS	No	Contralateral hemisphere
Case report									
Current study	25 (F)	Ischaemic stroke	9 months/Left	Dependent	No	Titanium	CVSD	No	Contralateral hemisphere
Cohort study (1.05% -including three previously reported TBI patients)	74 (F)	Ischaemic stroke	2 months/Right	Dependent	No	Autologous	CVSD	Yes	Contralateral hemisphere
	41 (F)	ICH	2 months/Right	Dependent	No	Titanium	CVSD	Yes	Contralateral hemisphere

CVSD = closed vacuum suction drain, F = female, ICH = intracerebral haemorrhage, M = male, NS = not specified, PEEK = polyether ether ketone, postop = postoperative, preop = preoperative, SAH = subarachnoid haemorrhage, TBI = traumatic brain injury, VP = ventriculoperitoneal.