



## Emergent Decompressive Craniectomy in Patients with Fixed Dilated Pupils; A Single Center Experience

Luis Rafael Moscote-Salazar<sup>\*1</sup>, Hernando Raphael Alvis-Miranda<sup>1</sup>, Camilo Palencia<sup>2</sup>, Andres M. Rubiano<sup>3</sup>

<sup>1</sup>University of Cartagena, Cartagena de Indias, Colombia, South America

<sup>2</sup>University of Rafael Nuñez, Cartagena de Indias, Colombia, South America

<sup>3</sup>Hospital Universitario de Neiva, Huila, Colombia

**Corresponding author:** Luis Rafael Moscote-Salazar

Address: Universidad de Cartagena, Cartagena de Indias, Colombia, South America.  
e-mail: mineurocirujano@aol.com

Received: July 10, 2013

Revised: August 8, 2013

Accepted: September 3, 2013

### ► ABSTRACT

This is a case series which report the clinical results of decompressive craniectomy in 4 patients with dilated pupils secondary to traumatic brain injury and postoperative edema. Between 2011 and 2012, four patients, 3 males and 1 female, aged between 35 and 64 with mean age of  $50.1 \pm 8.9$  years, underwent decompressive craniectomy due to brain traumatic edema. The follow up period ranged between 1 to 6 months. All patients had Glasgow coma score (GCS) of 3-4 at admission, and the duration of pupils being mydriatic was less than 20 minutes before the operation. All patients had moderate disability with GCS of 4 after the operation. Decompressive craniectomy can be a life-saving procedure which provides a better outcome in patients with dilated pupils secondary to brain trauma injury and postoperative edema with timing of less than 20 minutes. However, the small number of the patients in this study is the main limitation to the accuracy of the results, and more studies with larger number of patients are warranted to evaluate the efficiency of decompressive craniectomy in patients with dilated pupils.

**Keywords:** Decompressive craniectomy; Intracranial hypertension; Brain edema.

Please cite this paper as:

Moscote-Salazar LR, Alvis-Miranda HR, Palencia C, Rubiano AM. Emergent Decompressive Craniectomy in Patients with Fixed Dilated Pupils; A Single Center Experience. *Bull Emerg Trauma*. 2013;1(4):175-178.

**I**ntracranial hypertension is the leading cause of mortality in patients with cranial injury [1]. Currently the head injury has been considered as a public health problem worldwide. Decompressive craniectomy emerges as a treatment strategy for patients with refractory intracranial hypertension [2,3]. This involves partial resection of the cranial vault in order to provide more space for the brain and thus relieve intracranial hypertension. Surgical decompression procedures are a controversial topic, but there is some evidence that their use can reduce mortality rates [2].

Between 2011 and 2012 four patients with mydriatic pupils, less than 20 minutes of evolution of mydriasis

underwent surgical operation. All patients received standard treatment in our intensive care units. Three patients became highly torpid after following the instructions of the Brain Trauma Foundation, and as a last resort were chosen for decompressive craniectomy, using a modified standard trauma incision. Intracranial pressure was not monitored in any of the patients. There were no complications during the intraoperative and postoperative periods. The ideal technique implies the removal of bone in the entire supratentorial hemisphericum. One of the most important landmarks for this procedure is the root of the zygoma, which identifies the floor of the temporal fossa. The other important landmarks

include the asterion that represents the confluence of the lamboid, occipitotemporal, and temporoparietal sutures and indicates the area of transition between the transverse and sigmoid sinuses, the keyhole that identifies the pterion which demonstrates the location of the frontal, temporal, and orbital cavities, and lastly the inion, the glabella, and the midline that delineate the course of the superior sagittal sinus. When the patient's head is placed in the headholder, it is ideal that the sagittal plane of the head be horizontal to the floor.

Emergent decompressive craniectomy in patients with fixed dilated pupils was conducted in four cases. The mean age of the patients was  $50.1 \pm 8.9$  (ranging from 35 to 64) years and among them there were 3 (75.0%) men and 1 (25.0%) women. The Glasgow Coma Score (GCS) was 3-4 in all the patients before the operation. Decompressive craniectomy was performed in four selected patients with severe head trauma in which the lesions were mainly right-sided and included subdural hematoma and contusions. All the patients had bilateral mydriasis without response to light. The duration of pupils becoming mydriatic before the operation was less than 20 minutes. The follow up period ranged between 1 to 6 months. All the patients had moderate disability with GCS of 4-5 after the operation.

Morbidity and mortality due to neurotrauma, is considered as a major public health concern. It ranks among the leading causes of death and occurs in all regions, affecting people in all age and income groups [1]. Traumatic brain injury (TBI) have a broad range of consequences, accounting at least for half of the deaths due to trauma, and imposing financial burden on the health systems and high costs on the patient's rehabilitation [2-4]. The available evidence report a mortality due to TBI ranging from 35% to 42%, especially in patients aged from 15 to 25 year [3,5,6]. Classically, the Glasgow Coma Scale (GCS) and the pupillary status have been two of the most important independent indicators for determining prognosis in patients with severe TBI [7]. Pupillary status is considered less likely to be influenced by pre-hospital interventions [8] and provide an accurate neurological sign.

Patients with severe TBI can be comatose, and in this setting, the founding of a fixed and dilated pupil (FDP) has been recognized as both an emergency situation and a grave prognostic sign [9]. For the neurosurgeon, a FDP following trauma is one of the most meaningful focal finding in the neurological examination in the emergency room. Bilateral fixed dilated pupils has been defined as a pupillary diameter  $>4$  mm and non-reactivity to light [7]. Fixed and dilated pupils in comatose patients are strongly

associated with poor prognosis, especially when presented bilaterally [8,10-13]. The IMPACT database has shown an odds ratio for death of 2.49 for a single FDP and 5.50 for bilateral FDP [8,9]. The finding of (uni/bilateral) FDPs indicates the mandatory obligation to take quick and rational decisions on diagnostic and treatment procedures [14]. Failure to monitor pupils, while the patient is intubated and sedated, is one of the recurring problems observed during management of traumatic brain injury [15]. FDPs when not caused by drug action or by local trauma indicates injury or compression of the third cranial nerve and more severely, the upper brain stem, secondary to an expanding intracranial mass lesion or by diffuse brain injury [16,17] like mass effect or skull fractures. However, traumatic bilateral orbital wall fractures associated with optic nerve injury can result in bilateral FDPs without brainstem injury [18]. Sympathomimetic or parasympatholytic drugs should be taken into account [19].

Helmy *et al.*, [9] determined the commonest conditions to cause an FDP (uni/bilateral) including diffuse brain injury, acute subdural haematoma and contusions. In patients with unilateral FDP, the side of pupillary dilatation is ipsilateral to a lateralized condition in only 34% of cases, and in 9% of cases the side of pupillary dilatation is contralateral to the lateralized condition [9]. It is extremely important to perform serial measurements because the patient with reactive pupils can present FDP on arriving at the hospital, or may recover pupillary function at some stage [7].

The decompressive craniectomy can have an important impact because the pathophysiological indication is the inability of skull to expand with lesions of increasing size, as explained above. There are evidences evaluating the prognosis of patients with FDPs and TBI. In this context, Sakas *et al.*, [10] sought to determine the factors influencing quality of survival and the criteria for management of their patients. They studied 40 patients with bilateral FDPs who underwent a craniotomy for traumatic haematoma, of which 25% showed functional recovery. There were three groups of patients with no survivors. They included those who were GCS equal to 3, the patients undergoing surgical operation longer than 6 h after developing fixed pupils, and the patients older than 65 years [10].

Clusman *et al.*, [5] studied 99 patients with unilateral or bilateral FDP of which 46, 41 and 12 patients had trauma, stroke, and post-elective surgery respectively. In regard to the trauma group from the 46 patients, 20 had unilateral and 26 had bilateral FDP. The dominant findings of the initial cerebral CT-scan showed acute subdural hematomas in 19, contusions in 11,

diffuse brain edema in 10, and epidural hematomas in 5 patients, with hemorrhagic brain contusion associated with systemic coagulopathy in one case. Of 30 patients with delayed treatment, 16 cases received treatment with a delay of less than 100 minutes, and 14 subjects did not survive because of longer delays for preclinical reasons and for delayed admission to neurosurgical care unit. In patients with shorter delay, the rate of survival with Glasgow Outcome Scale (GOS) of 5 was 31.3%, and in those with longer delay and GOS of 2 was 14.3%. The overall mortality was 60.0% for the patients with unilateral and 84.6% for cases with bilateral FDP. In the patients with conservative management the mortality was as high as 94.7% compared to 59.3% in those who underwent surgery ( $p < 0.05$ ).

The favorable outcome in younger patients (mean age 22.5 years) was due to extradural haematomas compared with those (mean age of 45.6 years) having poor outcome. The Clusman et al, study led to the conclusion that a short time between pupillary dilatation and intervention improved the chance of recovery [14]. Cheung *et al.*, [20] in their study of outcome with traumatic extradural hematoma in Hong Kong, measured GCS only on admission to hospital and found no survivors in 3 patients with traumatic acute extradural hematoma who were GCS 3 with bilateral FDP, despite emergency evacuation of intracranial hematoma. They concluded that combination of bilateral FDP and GCS of 3 in three patients suggested a severe brain and brainstem lesion, thereby warranting the emergency evacuation of intracranial hematomas, which did not help reverse the damage to the brainstem.

Chaudhuri *et al.*, [7] identified 93 TBI patients with bilateral FDP and GCS 3 on presentation with only 6 survivors. They all underwent emergency craniotomy to evacuate lesions. They noted that 4 patients with GOS 4 or 5 had higher GCS scores before admission to the hospital. This indicates the importance of evaluating GCS scores at different times, a single point estimate is not enough to deem a patient unsalvageable [7]. A lesion amenable to evacuation and a rapid response of pupils to the treatment with hyperosmolar agents were identified as factors modifying the chance of survival. Helmy *et al.*, [9] in their prospective study with 60 patients admitted to a regional neurosurgical centre with diagnosis of TBI and unilateral or bilateral FDP found that most patients with bilateral FDP did not survive (88%). However, none of the surviving patients were persistently vegetative or had any ophthalmological sequel. Furthermore, the patients with unilateral FDP on admission who survived to 6 months had high incidence of ophthalmologic sequel (72%), and generally third nerve palsy [9].

In conclusion, the finding of FDPs indicates a grave prognostic sign following TBI, but can attain favorable outcomes. However, patients with GCS equal to 3 and normal pupil reactivity has better chances of survival and are comparable with those having bilateral fixed dilated pupils and higher GCS scores. Decompressive craniectomy performed in selected patients with mydriatic pupils even offers a chance of saving patients' lives.

**Conflict of Interest:** None declared.

## References

- Hyder AA, Aggarwal A. The increasing burden of injuries in Eastern Europe and Eurasia: Making the case for safety investments. *Health Policy* 2009;**89**(1):1-13.
- Alvis-Miranda H, Castellar-Leones SM, Moscote-Salazar LR. Decompressive Craniectomy and Traumatic Brain Injury: A Review. *Bull Emerg Trauma* 2013;**1**(2):60-68.
- Engel DC, Mikocka-Walus A, Cameron PA, Maegele M. Pre-hospital and in-hospital parameters and outcomes in patients with traumatic brain injury: A comparison between German and Australian trauma registries. *Injury* 2010;**41**(9):901-6.
- Arango-Lasprilla JC, Ketchum JM, Cifu D, Hammond F, Castillo C, Nicholls E, et al. Predictors of extended rehabilitation length of stay after traumatic brain injury. *Arch Phys Med Rehabil* 2010;**91**(10):1495-504.
- Engberg A. Severe traumatic brain injury--epidemiology, external causes, prevention, and rehabilitation of mental and physical sequelae. *Acta Neurol Scand Suppl* 1995;**164**:1-151.
- Arabi YM, Haddad S, Tamim HM, Al-Dawood A, Al-Qahtani S, Ferayan A, et al. Mortality reduction after implementing a clinical practice guidelines-based management protocol for severe traumatic brain injury. *J Crit Care* 2010;**25**(2):190-5.
- Chaudhuri K, Malham GM, Rosenfeld JV. Survival of trauma patients with coma and bilateral fixed dilated pupils. *Injury* 2009;**40**(1):28-32.
- Marmarou A, Lu J, Butcher I, McHugh GS, Murray GD, Steyerberg EW, et al. Prognostic value of the Glasgow Coma Scale and pupil reactivity in traumatic brain injury assessed pre-hospital and on enrollment: an IMPACT analysis. *J Neurotrauma* 2007;**24**(2):270-80.
- Helmy A, Kirkpatrick PJ, Seeley HM, Corteen E, Menon DK, Hutchinson PJ. Fixed, dilated pupils following traumatic brain injury: historical perspectives, causes and ophthalmological sequelae. *Acta Neurochir Suppl* 2012;**114**:295-9.
- Sakas DE, Bullock MR, Teasdale GM. One-year outcome following craniotomy for traumatic hematoma in patients with fixed dilated pupils. *J Neurosurg* 1995;**82**(6):961-5.
- Andrews BT, Pitts LH, Lovely MP, Bartkowski H. Is computed

- tomographic scanning necessary in patients with tentorial herniation? Results of immediate surgical exploration without computed tomography in 100 patients. *Neurosurgery* 1986;**19**(3):408-14.
12. Krieger D, Adams HP, Schwarz S, Rieke K, Aschoff A, Hacke W. Prognostic and clinical relevance of pupillary responses, intracranial pressure monitoring, and brainstem auditory evoked potentials in comatose patients with acute supratentorial mass lesions. *Crit Care Med* 1993;**21**(12):1944-50.
  13. Choi SC, Barnes TY, Bullock R, Germanson TA, Marmarou A, Young HF. Temporal profile of outcomes in severe head injury. *J Neurosurg* 1994;**81**(2):169-73.
  14. Clusmann H, Schaller C, Schramm J. Fixed and dilated pupils after trauma, stroke, and previous intracranial surgery: management and outcome. *J Neurol Neurosurg Psychiatry* 2001;**71**(2):175-81.
  15. Appleby I. Traumatic brain injury: initial resuscitation and transfer. *Anaesthesia & Intensive Care Medicine* 2008;**9**(5):193-6.
  16. Andrews BT, Chiles BW 3rd, Olsen WL, Pitts LH. The effect of intracerebral hematoma location on the risk of brain-stem compression and on clinical outcome. *J Neurosurg* 1988;**69**(4):518-22.
  17. Seelig JM, Greenberg RP, Becker DP, Miller JD, Choi SC. Reversible brain-stem dysfunction following acute traumatic subdural hematoma: a clinical and electrophysiological study. *J Neurosurg* 1981;**55**(4):516-23.
  18. He D, Blomquist PH, Ellis E 3rd. Association between ocular injuries and internal orbital fractures. *J Oral Maxillofac Surg* 2007;**65**(4):713-20.
  19. Thomas PD. The differential diagnosis of fixed dilated pupils: a case report and review. *Crit Care Resusc* 2000;**2**(1):34-7.
  20. Cheung PS, Lam JM, Yeung JH, Graham CA, Rainer TH. Outcome of traumatic extradural haematoma in Hong Kong. *Injury* 2007;**38**(1):76-80.