Decompressive Craniectomy in Traumatic Brain Injuries. Indications and Limits

Y. Tahrir, A. Laaidi, K. Baayoud, M. Makhchoune, A. Chellaoui, and A. Naja

ABSTRACT

Background: Decompressive craniectomy is a surgical technique proposed in the treatment of intracranial hypertension refractory to medical treatment and engaging the vital prognosis of patients.

Materials and methods: We conducted a retrospective study about 41 cases of decompressive flap in the neurosurgery department of CHU ibn Rochd of Casablanca between 2015 and 2018.

Aim: This study aims to discuss the management of intractable ICH in adults, focusing on the role of DC in patients with traumatic brain and identify the different indications, contraindications and complications.

Results: The results show a clear male predominance with an average age of 40 years. The initial GCS >7 was in 63%, and <7 in 36% of cases, anisocoria was present in 65%. The most frequent indication for craniectomy is a neurological worsening. The type of craniectomy performed in the majority of cases is a hemi craniectomy in 92% of cases. Concerning the prognosis, we observed 32% of deaths and 68% of survivors of which 39% of patients without sequelae GOS 5 and 32% with a moderate disability GOS 4. The moderate disability GOS 3 was found in 21% and one case in vegetative state GOS 2. Regarding immediate complications after craniectomy: 33% of patients presented convulsions, 12% a new homolateral hematoma, 49% a nosocomial pneumopathy and 10% a postoperative meningitis.

Conclusion: Decisions to recommend DC must always be made not only in the context of its clinical indications but also after consideration of an individual patient's preferences and quality of life expectations.

Keywords: Decompressive craniectomy, Brain trauma injury, Intracranial hypertension, Indications.

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I. INTRODUCTION

Decompressive craniectomy (DC) is a technique proposed for the treatment of intracranial hypertension (ICH) secondary to cerebral aggression. Following severe head trauma, medical and surgical treatments are initiated with the objective of minimizing and preventing secondary brain injury [1]. However, many patients present with ICH refractory to first-line treatments. DC is performed in these cases to control intracranial pressure (ICP) [2]. Due to the rigid nature of the skull and the dura, brain edema, expanding hematomas, or blossoming of contusions can rapidly exhaust the compensation mechanisms leading to maintenance of a controlled ICP. These events lead to a vicious cycle whereby reduced cerebral perfusion pressure (CPP) causes reduction of cerebral blood flow (CBF) and oxygenation, with worsening of brain edema and, eventually, brain herniation, and death. It consists of a wide fronto-temporal flap associated with a dural enlargement

plasty. Improve the compliance of the system by making the cranial cavity extensible is the rationale for using of DC [3]. Indeed, DC increases the volume that the brain could occupy and minimizes the risk of cerebral ischemia by allowing an increase in cerebral blood flow and tissue oxygenation [4], [5]. DC reduces ICP and mortality; it appears to be associated with an improvement in the vital prognosis and functional prognosis of patients [6]. The choice to perform decompressive craniectomy is not a simple decision and the potential benefits should be balanced against the complications and likely outcomes on a case-by-case basis.

II. MATERIALS AND METHODS

We carried out a retrospective study of 41 cases admitted to the neurosurgical emergency department, Ibn Rochd University Hospital in Casablanca between 2015 and 2018. All our patients are treated by a decompressive craniectomy.

This study aims to discuss the management of refractory ICH in adults, focusing on the role of DC in patients with traumatic brain and identify the different indications, contraindications and complications.

III. RESULTS

The age varied between 16 and 63 years with an average age of 40 years, a male predominance at 72% was objectified with a sex ratio of 2.6. The mechanism is dominated by Public road accident at 47% followed by fall from high place at 26% then aggression at 20% and 7% other. The admission time after symptomatology was between 6 hours and 24 hours in 49% of cases and only 24% of cases were referred to the emergency room before 6 hours. On admission, 54% of cases have a GCS between 8 and 11 and 36% have a GCS of 7, and 49% presented a GCS <7. Intraoperatively 66% of our patients presented anisocoria, miosis in 5%, mydriasis in 7% of cases and 22% of patients showed no pupillary signs, with viable trunk reflexes in all patients. ICH syndrome is the master symptom, signs of deficiency were assessed in 7.3% of patients, and 24.4% of patients presented with convulsions. All patients underwent CT scan demonstrating an acute subdural hematoma in 61% of cases (Fig. 1), and edema-hemorrhagic contusions in 58% of cases, with a combination of the two lesions in 29% of cases. Intra parenchymal hematoma is found in 51% of patients. The most frequent indications for craniectomy are neurological worsening with midline shift superior than 10 mm, also ICH refractory adequate medical treatment and age < 65 years. The type of decompressive craniectomy performed in the majority of cases is hemi craniectomy in 92% (Fig. 2), and bi-frontal in 8% of cases. The origin of the bleeding was the cortical veins injuries and brain contusions in most cases.

Concerning the prognosis, we observed 32% of deaths, in immediate postoperative period, among them, 69% had a GCS < 8 and 32% between 8 and 11 GCS. The most affected age group was over 56 years old in 46% of the cases and 54% of the cases between 26 and 55 years. Of the 28 patients who survived (69%), 11 patients (39%) were reported to have no sequelae GOS 5, 9 patients (32%) with a moderate disability GOS 4. 6 patients (21%) had a moderate disability GOS 3 and one case in a vegetative state GOS 2. Regarding complications after craniectomy: 33% of patients presented convulsions, 12% a new homolateral hematoma, 49% nosocomial pneumonia and 10% postoperative meningitis. Note that 5 cases returned for cranioplasty before 9 months.

Fig. 1. CT scan Brain showing: left fronto-parieto-temporal acute subdural haematoma with mass effect and midline shift.

Fig. 2. Image showing the evacuation of an acute subdural hematoma during surgery after hemi-craniectomy.

IV. DISCUSSION

The best time to decompress a patient is still under discussion [7], but early DC (within 24 h after injury) is recommended for severely head injured patients without brain stem dysfunction requiring neurosurgery for removing intracranial collections [8]. Also, data suggested that complications of traumatic brain injury (TBI) may be reduced following early DC [9]-[12]. This decision can be made intraoperatively based on the patient's mechanism of injury, age, degree of underlying cerebral swelling, atrophy, or both; and the surgeon's estimation of the likelihood that the patient will develop severe ICH [13]. Should be noted that in places where multimodal monitoring, DC can be the choice treatment to prevent brain herniation [14].

Otherwise, the outcome of the patients who undergo late DC (after 24 h) is more encouraging [15]. However, regard to TBI, according to the European Brain Injury Consortium and Brain Trauma Foundation guidelines for severe TBIs, DC should be incorporated to the second-tier therapeutic arsenal in patients with refractory ICH to first-tier therapeutic measures [11], [14], [16], [18], when appropriate targeted surgery and medical treatment fails, DC is the option [15].

The European Brain Injury Consortium (EBIC) and the joint Brain Trauma Foundation (BTF) and American Association of Neurological Surgeons (AANS) guidelines for severe head injuries describe DC as a therapeutic option for brain oedema that is refractory to conventional therapeutic measurements [16], [17].

The indications for DC are difficult to establish even when the patient's lesions are significant and give rise to fears of persistent sequelae. It seems preferable to operate on young patients, whose initial Glasgow score is higher than 4, whose neurological worsening is progressive, whose lesions are sustentorial and whose ICH is due to a focal contusion [18]. In our study, the patients operated on were mainly young subjects and the majority had a GCS between

8 and 11.

Two possible times of performing DC, allowing it to be defined as preventive or secondary, are described in the literature [19], [20]. Preventive DC is performed concomitantly with the evacuation of hemorrhagic lesions, such as an acute subdural hematoma, in the early phase of management, before the occurrence of ICH. Seizing the opportunity of performing surgery in the early phase to increase the compliance reserve and prevent the occurrence of ICH is the rationale for using preventive DC. It finds its place during the surgical management of the lesion for which the majority of patients suffering from head trauma are operated, the acute subdural hematoma. This is most often associated with other intracranial lesions likely to contribute to the development of cerebral oedema and ICH [19].

Secondary DC is performed in patients with ICH. Its interest, in the early phase of ICH, for neuroprotective purposes before optimization of medical treatment, has been evaluated in a single randomized study, the DECRA study [1], including 155 patients. Head injury patients with diffuse brain lesions, without other associated intracranial lesions, with intracranial hypertension (defined as ICP > 20 mmHg for more than 15 minutes in a period of one hour), were randomized into two groups, bifrontal craniectomy associated with medical treatment and exclusive medical treatment of the ICP. The results showed a benefit on ICP, duration of mechanical ventilation and intensive care unit (ICU) stay but no benefit on functional neurological prognosis at 6 months, with an increase in the number of vegetative patients in the DC group.

In the Brain Trauma Foundation guidelines [21], bifrontal craniectomy is not recommended to improve the 6-month functional prognosis of severe head trauma patients with diffuse brain injury and ICH refractory to first-line medical treatment. However, it reduces ICP and length of stay in the ICU for patients. A large fronto-temporo-parietal flap is recommended. It reduces mortality and improves the functional prognosis of severe head trauma patients.

As mentioned by Lubillo et al. [14] contraindications for DC are patients with GCS 3 post-resuscitation with dilated and fixed pupils, patient >65 years old devastating trauma that won't allow patient survive more than 24 h irreversible systemic disease in the short term, uncontrollable ICH during more than 12 h besides all energetic therapeutic measures and O₂ arterio-venous difference <3,2 vol%, measured in the side of hemicraniectomy or a PtiO₂ <10 mmHg in the apparently health area since patient admission. In our study, all patients operated on had a GCS between 3 and 13. Only one patient was operated on with bilateral are active mydriasis, with an admission GCS of 3.

Complications are more frequent in patients with low GCS and those over 60 years [23]. Nearly 50% of patients had at least one complication [24]. They can be early, dominated by hematomas, or secondary with the appearance of hygroma and infections. First complications can happen are expansion of hemorrhagic contusion, followed by appearance of new subdural hematoma on contralateral side, seizures, leakage of CSF, and brain herniation [21]. Herniation through the craniectomy defect, happening in up to 27.8% of patients; a though to counteract this

phenomenon is to perform a DC, as large as possible [23].

Subdural effusion happens in near 21.3%, probably due to cerebrospinal fluid (CSF) disturbances derived from the DC itself. Contralateral subdural effusion caused by DC has rarely been reported [22]. This complication may relate with postoperative neurological deterioration or raised ICP [23], [25], [26]. Post-traumatic hydrocephalus, its occurrence range in up to 9.3%; probably because severely injured patients cannot show clinical symptom, CT scan can be extremely useful for the detection of patients developing dilatations or ventricular shifts [23]. Trepanning syndrome associating headaches, irritability, cognitive and mood disorders, appearance of a new deficit, most often a hemiparesis. The data from our studies match those from the literature.

V. CONCLUSION

DC is a treatment of last resort in the treatment of post-traumatic ICH. The decision to perform DC must be made in a collegial manner. In the future will be the conduct of clinical trials to standardize the correct technique, surgical timing and makes a better choice of patients suitable for this technique.

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