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Review Article

Decompressive Craniectomy Versus Cisternostomy in Traumatic Intracranial Hypertension. Systematic Review

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Abstract

To compare the usefulness of decompressive craniectomy versus cisternostomy in the surgical management of Traumatic Intracranial Hypertension was the objective of the present bibliographic review. A search was carried out for articles in journals from the databases: PubMed, Scielo and EBSCO. The key words used were: intracranial hypertension, severe craniocerebral trauma, decompressive craniectomy and cisternostomy. Searches were conducted with these terms in English and Spanish. Articles with the full text were consulted, published mainly between 2015 and 2023 in Spanish or English, although in multicenter and multinational studies with high global impact on the topic, the year of publication was not taken into account, given the importance of its inclusion in the present review. Articles that reflected controversies about Decompressive Craniectomy and Cisternostomy as a measure in ICH refractory to medical treatment were selected with priority. Decompressive craniectomy and Cisternostomy are surgical methods that have been shown to reduce intracranial pressure and mortality in patients with traumatic intracranial hypertension refractory to medical therapy, although decompressive craniectomy presents a higher and more reliable level of evidence than cisternostomy, the new mechanisms for reducing intracranial pressure in the latter procedure seem promising in the near future.

***Keywords:** Decompressive craniectomy, Cisternostomy, Traumatic Intracranial Hypertension*

Introduction

Intracranial Pressure (ICP) is defined as the pressure within the cranial vault with values in adults ranging between 5 – 15 mmHg. According to the Monro-Kellie theory, the intracranial content is divided into 3 components: the brain parenchyma, the cerebrospinal fluid (CSF) and the blood. When any of the 3 intracranial components increases due to some pathological condition, one or both of the remaining components decreases to compensate for balance and maintain a constant ICP.[1]

Physiologically, the brain has a cerebral perfusion pressure (CPP) between 50 -150 mmHg, this is equivalent to the difference between mean arterial pressure and ICP; so that by raising ICP, it can reduce CPP. A reduction in CPP below 50 mmHg can lead to ischemic injury and cerebral edema.[2,3,4] The pathological increase in ICP may be due to: injury of extrinsic origin, increased blood volume, increased CSF volume, increased cellular tissue volume.[2]

When ICP varies due to any of the given causes, what is known as compensation initially occurs, where blood and CSF move around the spinal axis and normal ICP values are maintained.[2,5] When the limits of the compensatory mechanisms are exceeded, an increase in ICP occurs.[1] This increase is nothing more than a decompensation resulting from the pressure exerted by the CSF in the cerebral ventricles and the blood volume itself that flows through the central nervous system.[2] Finally, when all the reserve spaces are used, the brain begins to move due to pressure difference, through the folds of dura mater (*falx cerebri and tentorium*), and through the foramen magnum, in what is called cerebral herniations.[6]

Objective

Compare the usefulness of decompressive Craniectomy versus Cisternostomy in the surgical management of Traumatic Intracranial Hypertension.

Material and Method

A search was carried out for articles in journals from the databases: PubMed, Scielo and EBSCO. The key words used were: intracranial hypertension, severe craniocerebral trauma, decompressive craniectomy and cisternostomy. Searches were conducted with these terms in English and Spanish.

Articles with the full text were consulted, published mainly between 2015 and 2023 in Spanish or English, although in multicenter and multinational studies with high global impact on the topic, the year of publication was not taken into account, given the importance of its inclusion in the present review. Articles that reflected controversies about Decompressive Craniectomy and Cisternostomy as a measure in ICH refractory to medical treatment were selected with priority.

Development

Decompressive Craniectomy (DC)

Currently, the treatment of ICH has been governed by the therapeutic management guidelines of the Brain Trauma Foundation, although it constitutes a particularly controversial issue, precisely because they are essentially based on the results presented in the two most important studies that analyze the effectiveness of DC in different populations: DECRA and RESCUEicp, investigations that, due to their high level of evidence and methodological support, displace the results presented in lower quality studies.

Randomized Evaluation of Surgery with Craniectomy for Uncontrollable Elevation of Intracranial Pressure (RESCUEicp), constitutes a randomized, international, multicenter clinical trial; comparing last-level secondary DC with continued medical treatment for refractory ICH after TBI from 2004 to 2014.[7]

For its part, Decompressive Craniectomy in Diffuse Traumatic Brain Injury (DECRA), constitutes a randomized, international and multicenter clinical trial, where the participants were adults with diffuse TBI and refractory HTIC who were assigned first-level therapies to undergo a Bifrontotemporoparietal DC or standard care, from 2002 to 2010.[8]

They presented reductions in the intracranial hypertension index and a reduction in the cerebral hypoperfusion index that were statistically significant. They spent less time on mechanical ventilation and fewer days in the ICU, although there were no statistically significant differences in overall length of hospital stay. Complications related to the treatment were greater in patients undergoing DC (37% vs. 17%), highlighting Hydrocephalus (10% vs. 1%). The evaluation of the functional outcome at 6 months revealed a greater proportion of unfavorable results in surgically treated patients with Glasgow scale 3 versus 4, (odds ratio (OR) 1.84; 95% confidence interval (CI) 1.05–3.24; p= 0.03).Overall unfavorable outcomes occurred in 70% of patients undergoing craniectomy compared with 51% of patients treated with standard medical care. There were no statistically significant differences in mortality between patients treated with decompressive hemicraniectomy compared with those treated with standard medical care.[6, 8, 9]

For its part, in RESCUEicp, at 6 months mortality was 26.9% and 48.9%, respectively in the surgical and medical groups; The Glasgow scale had a higher score in those who underwent surgery. The results at 12 months were as follows: mortality of 30.4% (194 patients) in the DC group versus 52% (179) in the medical treatment group.

The Glasgow scale was higher in patients who underwent DC. The authors of this study concluded that patients treated surgically had lower mortality, a higher percentage of vegetative state, complete dependence, and moderate disability than those treated medically. There was a higher percentage of adverse effects in the surgical group. Of 100 patients who underwent DC, 22 more survivors were obtained than in the medical group, of which 5 were in a vegetative state; 4, completely dependent, and 13 had different degrees of disabilities.[6, 7, 9]

The study carried out by Cooper et al, better known as DECRA [8], has received strong criticism for not taking into account some factors such as surgical technique, and not discriminating additional injuries and prehospital management in patients.[9,10] Some authors criticize the choosing ICP greater than 20 mmHg for 15 minutes in 1 hour as a criterion for intervention. They argue that most practitioners would not intervene in practice even if the study ICP parameters were met, as 20 mmHg was too low and 15 minutes too short to justify any risk associated with the treatment.[11] Regardless of potential biases applied to the study, its scientific evidence continues to be a source of contradictions in the international scientific community.

As objections in RESCUEicp, an inclusion rate of 20.36% is presented, after 10 years of selection. Medical therapy was established in a heterogeneous way, without a uniform protocol. The protocol recommends maintaining cerebral perfusion pressure levels > 60 mmHg, contrary to current guidelines, 63% of the patients underwent bifrontal decompression, however, the final results are not discriminated according to the technique used. It is not clear when, nor the reason, nor the technique used.[6]

Cisternostomy

Cisternostomy is defined as the opening of the basal cisterns to atmospheric pressure. The brain is surrounded by cerebrospinal fluid. Cerebrospinal fluid is produced in the lateral, third and fourth ventricles at a rate of about 500 ml per day. Cerebrospinal fluid passes from the fourth ventricle to the cisterns through the foramen of Magendie and Luschka. The cisterns contain about 120 ml of cerebrospinal fluid. Current theory states that cerebrospinal fluid is absorbed into the main venous sinuses through arachnoid granulations. However, the glymphatic system has shown that cerebrospinal fluid from the cisterns (and not the ventricles) does communicate with the parenchyma through the Virchow Robin spaces. [12, 13] Since the cisterns and the brain communicate, it would be possible to reduce the pressure in both compartments by opening the cisterns to atmospheric pressure. This will cause a retreat of cerebrospinal fluid through the Virchow Robin spaces, resulting in a decrease in intracerebral pressure. Draining the cerebrospinal fluid from the cisterns over the next 5 days is beneficial because lactate, tau, and free radicals that would have been present in the injured brain are removed, minimizing secondary damage.[12, 13]

Cisternostomy has been very useful as an adjuvant procedure to decompressive craniectomy in severe head injury[14], where the difference in results was particularly relevant when cisternostomy was performed as a primary procedure; they also had significantly lower average post-surgical ICP values, higher PbO2 and required fewer osmotic treatments compared to those treated with DC alone, although as a fundamental limitation the data obtained were provided by a single hospital center.

Other authors suggest that there was no significant difference in terms of morbidity and mortality between the use of DC plus Cisternostomy compared to the practice of Cisternostomy alone in patients candidates for cerebral decompression secondary to severe cranial trauma[15].

In 2022, an interesting article was published that reflects, through a controlled and randomized trial method, the results of the comparison DC versus Cisternostomy in patients with severe head injury[16], mortality was lower in patients with Cisternostomy, it was also effective for reduce ICP in patients with TBI. Good Glasgow Outcome Scale scores and low complication rates were found in the postoperative period after cisternostomy. Age, Glasgow Coma Scale score, Marshall score, other major injuries, and time from trauma to surgery had a significant prognostic impact on the outcome of TBI treatment.

Other authors have published evidence that demonstrates considerable effectiveness of Cisternostomy as a method to achieve the reduction of Traumatic Intracranial Hypertension [17, 18, 19, 20].

The main limitations of this technique are the learning curve of young Neurosurgeons to perform it effectively and the necessary instruments and equipment.

Considerations about the topic

In 2019, given the controversies over the DECRA and RESCUEicp studies, SIBICC emerged as a Seattle Consensus on Severe Traumatic Brain Injuries. It arises under a consensus approach and as an initiative due to the lack of evidence regarding the relative short- and long-term efficacy of the use of DC in severe TBI.[21]

In the first edition (2019), 18 interventions are established as essential for the care of severe TBI, and 10 treatments that should not be used. Established a three-level algorithm focused on the treatment of elevated ICP, with higher levels implying higher-risk therapies. They suggest considerations to address when progressing from lower to higher levels and recommendations for critical neurological worsening intended to assist in the recognition, evaluation, and treatment of patients in decline. Novel elements include guidance for self-regulation-based ICP management as well as two sets of heat maps to guide consideration of sedation holidays to facilitate neurological examination and ICP monitor removal.[21]

In its second edition, published in 2020, SIBICC used a consensus approach based on the Delphi method in an attempt to close the gap between the severe TBI guidelines available for individual treatments and the lack of evidence on how such treatments should be integrated. into a practical management algorithm. Three different treatment protocols are established, each with three levels in which higher levels imply higher risk therapies. One protocol addresses the management of elevated ICP when cerebral oxygenation is normal. A second addresses the management of cerebral hypoxia with normal ICP. The third protocol addresses the situation in which both intracranial hypertension and cerebral hypoxia are present. The panel considered issues related to blood transfusion and ventilator management when designing the different algorithms.[22]

Although SIBICC in its 2 editions provides class III scientific evidence, they constitute an attempt to clarify the existing fluctuations in the treatment of patients with severe TBI, under the initiative of a good number of experts in the care of neurocritical patients, however, the protocols They constitute suggestions that should not be extrapolated.

Brain Trauma Foundation, in the 2020 update of its guidelines on the treatment of severe traumatic brain injury, incorporates 3 new level IIA recommendations, and a fourth modified level IIA recommendation, based mainly on the evidence presented by the DECRA and RECUEicp studies.[23]

Level IIA to improve mortality and overall outcomes:[23]

- New: it is suggested to perform secondary DC for late refractory elevation of intracranial pressure in order to improve mortality and favorable outcomes.

- New: it is not suggested to perform secondary DC for early refractory elevation of intracranial pressure, in order to improve mortality and favorable outcomes.

- It is suggested to perform a frontoparietal DC with a diameter less than or equal to 15 cm in order to reduce mortality and improve neurological outcomes in patients with severe TBI.

- New: secondary DC is suggested as a treatment for early or late refractory elevation of intracranial pressure, in order to reduce ICP itself and the duration of intensive care. Although the relationship between these effects and the favorable outcome is uncertain.

In all these updates about the management of refractory intracranial hypertension, cisternostomy is not referred to with the same level of evidence as decompressive craniectomy.

Conclusions

Decompressive craniectomy and Cisternostomy are surgical methods that have been shown to reduce intracranial pressure and mortality in patients with traumatic intracranial hypertension refractory to medical therapy.

Conflicts of Interest

The authors certify that there is no conflict of interest.

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