Hyperosmolar therapy for intracranial hypertension

see Hyperosmolar therapy for children.

Hyperosmolar therapy has been the keystone of medical interventions used to control intracranial hypertension.

As early as 1783, Monro, Kellie, and other investigators advanced the notion that the volume of the brain is constant.

The landmark work of Weed and McKibben disproved this long-held dogma when they demonstrated dramatic changes in the volume of the brain resulting from administration of hypertonic or hypotonic intravenous solutions. Since that time, intravenous administration of hyperosmolar agents has become routine in the management of intracranial hypertension and herniation syndromes. However, the optimal agent, their optimal means of administration (i.e., dose and bolus vs. continuous infusion), and their precise mechanisms of action continue to be investigated.

In 1919 Weed and McKibben reported that hypertonic fluids could lower intracranial pressure and shrink nervous tissue [1].

Shortly thereafter Fay reported on “the treatment of cerebral trauma, by methods of dehydration” using intravenous hypertonic sodium and magnesium solutions [2].

It was not until the early 1960s, following the introduction of ICP monitoring in head injury, that mannitol came into more widespread use [3] [4] and turn into the agent of choice.

Recently, hypertonic saline has challenged mannitol’s role as the preferred osmotic agent [5].

A recent pro-con debate on osmotic therapy provides a complete summary of the argument for and against its use [6] [7].

Single doses of 3 ml/kg of 20% mannitol and 3% hypertonic saline (HS) are safe and effective for intraoperative brain debulking during elective supratentorial craniotomy, but less effective in patients with pre-existing mass effect and midline shift [8].

Hyperosmolar therapy, using either hypertonic saline (HTS) or mannitol (MT), is considered the treatment of choice for intracranial hypertension.

Results do not lend a specific recommendation to select hypertonic saline or mannitol as a first-line for the patients with elevated ICP caused by TBI. However, for the refractory intracranial hypertension, hypertonic saline seems to be preferred [9].

Complications

Hyperosmolar agents have been postulated to impair coagulation and platelet function.

Use of 3% HTS and 20% MT for the control of ICP did not significantly affect patients' coagulation function. Therefore, hyperosmotic solution is safe and does not increase the risk of intracranial rebleeding [10) 11)].

Mannitol and hypertonic saline in equiosmolar concentrations produced comparable effects on ICP reduction, brain relaxation, and systemic hemodynamics [12)].

Case series

see Hyperosmolar therapy for intracranial hypertension case series

1)
Weed LH, McKibbens PR. Experimental Alterations of Brain Bulk. Am J Physiol. 1919;48:512–530
2)
Fay T. The Treatment of Acute and Chronic Cases of Cerebral Trauma by Methods of Dehydration. Ann Surg. 1935;101:76–132
3)
Shenkin HA, Goluboff B, Haft H. The Use of Mannitol for the Reduction of Intracranial Pressure in Intracranial Surgery. J Neurosurg. 1962;19:897–901.
4)
Wise BL, Chater N. The Value of Hypertonic Mannitol Solution in Decreasing Brain Mass and Lowering Cerebro-Spinal-Fluid Pressure. J Neurosurg. 1962;19:1038–1043.
5)
Marko NF. Hypertonic Saline, Not Mannitol, Should Be Considered Gold-Standard Medical Therapy for Intracranial Hypertension. Crit Care. 2012;16:113. In this editorial the author makes the case for why HS should replace mannitol
6)
Grape S, Ravussin P. Pro: Osmotherapy for the Treatment of Acute Intracranial Hypertension. J Neurosurg Anesthesiol. 2012;24:402–406. A well -written option piece laying out the arguments in favor the use of osmotic therapy to treat elevated ICP
7)
Grande PO, Romner B. Osmotherapy in Brain Edema: A Questionable Therapy. J Neurosurg Anesthesiol. 2012;24:407–412.
8)
Hernández-Palazón J, Fuentes-García D, Doménech-Asensi P, Piqueras-Pérez C, Falcón-Araña L, Burguillos-López S. A comparison of equivolume, equiosmolar solutions of hypertonic saline and mannitol for brain relaxation during elective supratentorial craniotomy. Br J Neurosurg. 2015 Nov 16:1-6. [Epub ahead of print] PubMed PMID: 26571037.
9)
Gu J, Huang H, Huang Y, Sun H, Xu H. Hypertonic saline or mannitol for treating elevated intracranial pressure in traumatic brain injury: a meta-analysis of randomized controlled trials. Neurosurg Rev. 2018 Jun 15. doi: 10.1007/s10143-018-0991-8. [Epub ahead of print] PubMed PMID: 29905883.
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11) Hernández-Palazón J, Fuentes-García D, Doménech-Asensi P, Piqueras-Pérez C, Falcón-Araña L, Burguillos-López S. Equiosmolar Solutions of Hypertonic Saline and Mannitol Do Not Impair Blood Coagulation During Elective Intracranial Surgery. J Neurosurg Anesthesiol. 2017 Jan;29(1):8-13. PubMed PMID: 26580123.

12) Sokhal N, Rath GP, Chaturvedi A, Singh M, Dash HH. Comparison of 20% mannitol and 3% hypertonic saline on intracranial pressure and systemic hemodynamics. J Clin Neurosci. 2017 Aug;42:148-154. doi: 10.1016/j.jocn.2017.03.016. Epub 2017 Mar 22. PubMed PMID: 28342705.