An international based survey about preferences in neurosurgical irrigation fluids in neurotrauma procedures

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Abstract: *Background*: Traumatic brain injury surgery is the most frequently performed by neurosurgeons. The use of 0.9% saline solution (normal saline) irrigation and other solutions during neurosurgical procedures has been considered a cause of neural tissue injury. The normal saline has been used for many years, but at cellular level it may cause harmful changes. The emergence of new solutions, such as artificial cerebrospinal fluid and Ringer's lactate, seem to produce less damage effects on brain tissue. The aim of this study is to evaluate the trends in use of irrigation solutions in traumatic brain injury surgeries. *Materials and Methods*: This study was conducted through a web-based survey sent to 40 neurosurgeons worldwide. *Results*: Over the period of the study data was collected from the 40 physicians and the 100% of the respondents used any type of irrigation solution during neurosurgery. *Conclusion*: The use of normal saline in brain surgery is a widespread practice worldwide, despite the negative effects on neural tissue as it may contribute to further damage. The conception of new irrigation solutions for neurosurgery, especially in traumatic brain injury, may be a useful alternative for future studies and to expand our knowledge on this topic.

Key words: Traumatic brain injury, neurosurgery, Neurosurgical irrigation solution, Harmful effects, Physiological saline, Ringer's lactate solution, Artificial cerebrospinal fluid

Introduction

The routine use of various solutions such as 0.9% saline (normal saline), Ringer's lactate and others have been routinely used to replenish cerebrospinal fluid leaks during neurosurgical procedures. It was established

that the composition of the fluids is one of the factors associated with the development of cerebral edema. There are few published reports in the literature regarding irrigation solutions in neurosurgery (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12), but to date there is no published study focused on neurotrauma. In order to assess the current state of international trends on the use of irrigation solutions for traumatic brain injury surgery, an international web-based survey was conducted among neurosurgeons.

Materials and methods

The primary endpoint was to determine how neurosurgeons use irrigation solutions in traumatic brain injury surgery. We developed an international web-based structured survey with real time results through an online survey creator (http://www.encuestafacil.com). The survey invitations were sent by e-mail, and aimed neurosurgeons who manage patients with traumatic brain injury to meet their management techniques in relation to national and international guidelines on head trauma (6–8), during the months of September and October 2015. For ethical considerations, no institution affiliation was requested. We used dichotomous choice questions, and multiple choice questions with a single answer. Among the variables evaluated were: experience, occupation, type solutions, and the use of irrigation solutions in various traumatic brain injury surgeries. Answers from the survey were compiled and entered into an Excel database (Microsoft®, Redmond, Washington, USA). Each answer to a question was placed in a corresponding category and the frequencies of each category were computed. The data were analyzed by SPSS software 17.0 (Chicago, Illinois, USA).

Results

Forty neurosurgeons and residents worldwide completed the survey. Most of the respondents had between 5 and 20 years of experience (5-10 years with 30% [n=12] and 10-20 years with 27.5% [n=11]).

Only 22.5% (n=9) had 0-5 years and 20% (n=8) had more than 21 years of experience.

When asked about occupation, 30 (75%) were neurosurgeons and 10 (25%) were resident of neurosurgery. When asked about preferences of irrigation of solutions more frequently used during craniotomies, 82.5% (n=33) used normal saline solution, 12.5% (n=5) used Ringer's lactate, and 5% (n=2) used other type of solution. In regard to irrigation solutions used frequently during traumatic brain injury surgery, 82.5% (n=33) used normal saline, 10% (n=4) used Ringer's lactate, and 7.5% (n=3) used other type of solution. When asked about the solution used more frequently during decompressive craniectomy, 80% (n=32) used normal saline, 10% (n=4) used Ringer's lactate, and 10% (n=4) used other type of solution. When considering irrigation temperature, 55% (n=22) used solutions with corporal temperature, 5% (n=2) used cold solutions, and 40% (n=16) used solutions at room temperature. The use of irrigation solutions was based on institutional policy (20%; n=8), personal preferences (47.5; n=19), and both (32.5; n=13).

Discusion

In neurosurgical practice, very little attention has been given to deleterious effects of the solutions used for irrigation, despite the increase in the cerebral edema. In traumatic brain injury surgery it is crucial to understand the physiopatholgy of secondary post-traumatic cerebral edema, and therefore limiting additional injury to neural tissues. (13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24). In 1949, Elliott reported the first artificial cerebrospinal fluid, known as Elliot's solutions A and B. Today its use is restricted because of the high costs. Other potentially useful fluids developed in Japan as ARTCEREB show potential clinical uses at cellular level. (30) The presence of cerebral edema is well known to be a risk factor for morbidity and mortality in post-operative neurosurgery patients. Some surveys have studied trends in irrigation fluids in neurosurgery (29). In this study also it was also determined that the artificial cerebrospinal fluid is mainly used in the United States, Canada and Japan. Our results confirm data from the literature concerning that the election of irrigation solutions depends mainly on the surgeon's preference. In other tissues such as in the peritoneal cavity, it was shown that normal saline causes loss of fibrinolytic activity. (25, 26, 27, 28, 31). Among the characteristics that differentiate normal saline to cerebrospinal fluid are the pH, osmolality, concentration of inorganic salts, and the absence of glucose, protein, cholesterol and others.

Conclusion

Although a web-based survey does not represent the general population of neurosurgeons worldwide, it was designed in a simplistic fashion to facilitate the ease of answer. We conclude that it is necessary to improve the state of knowledge on irrigation solutions for traumatic brain injury surgery in order to limit post-operatory cerebral edema and cellular damage. Future work in the area is recommended.

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References

1.Pople, I.K., Ettles, E.D. The role of endoscopic choroids plexus coagulation in the management of hydrocephalus. Neurosurgery. 1995;36:698–702.
2.Uchida, K., Yamada, M., Hayashi, T., Mine, Y., Kawase, T. Possible harmful effects on central nervous system cells in the use of physiological saline as an irrigant during neurosurgical procedures. Surg Neurol. 2004;62:96–105.
3.Choi, S., McComb, J.G., Levy, M.L., Gonzalez-Gomez, I., Bayston, R. Use of elemental iodine for shunt infection prophylaxis. Neurosurgery. 2003;52:908–913.
4.Dubey, P.K., Singh, A.K. Venous oxygen embolism due to hydrogen peroxide irrigation during posterior fossa surgery. J Neurosurg Anesthesiol. 2000;12:54–56.
5.Milhorat, T.H. Cerebrospinal fluid physiology. Hydrocephalus and the cerebrospinal fluid. Williams and Wilkins, Baltimore; 1972 (p. 1–41).
6.Doi, K., Kawano, T., Morioka, Y., Fujita, Y., Nishimura, M. Various irrigation fluids affect postoperative brain edema and cellular damage during experimental neurosurgery in rats. Surg Neurol. 2006;66:565–571.
7.Elliott, K.A.C., Jasper, H.H. Physiological salt solutions for brain surgery: studies of local pH and pial vessel reactions to buffered and unbuffered isotonic solutions. J Neurosurg. 1949;6:140–152.
8.Lewis, R.C., Elliott, K.A.C. Clinical uses of an artificial cerebrospinal fluid. J Neurosurg. 1949;6:256–260.

9.Hansson, E., Vällfors, B. A study of irrigation fluids for neurosurgery on brain primary cell cultures. Cell Mol Life Sci. 1980;36:64–65.
10.Vällfors, B., Rosengren, L.E., Persson, L.I. Exposure of the cat brain surface to neurosurgical irrigation fluids, hydrogen peroxide and air. Quantitative assay of blood–brain barrier dysfunction. Acta Neurochir. 1982;64:225–232.
11.Vallfors, B., Hansson, H.A., Belghmaidi, M. Mesothelial cell integrity of the subdural and arachnoid surfaces of the cat brain after exposure to neurosurgical irrigation fluids and air: a scanning electron microscopicstudy. Neurosurgery. 1983;12:35–39.
12.Sakatani, K., Ohtaki, M., Morimoto, S., Hashi, K. Isotonic mannitol and the prevention of local heat generation and tissue adherence to bipolar diathermy forceps tips during electrical coagulation. Technical note. J Neurosurg. 1995;82:669–671.
13.Enomoto, R., Tatsuoka, H., Komai, T., Sugahara, C., Takemura, K., Yamauchi, A. et al, Involvement of histone phosphorylation in apoptosis of human astrocytes after exposure to saline solution. Neurochem Int. 2004;44:459–467.
14.Fujita, Y., Doi, K., Harada, D., Kamikawa, S. Modulation of physiological hemostasis by irrigation solution: comparison of various irrigation solutions using a mouse brain surface bleeding model. J Neurosurg. 2010;112:824–828.
15.Nishimura, M., Doi, K., Naito, S. Pharmacological assessment of ARTCEREB irrigation and perfusion solution for cerebrospinal surgery based on glucose incorporation activity in primary cultures of rat brain cells. Yakugaku Zasshi. 2010;130:127–130.
16.Salvador, L., Valero, R., Carrero, E., Caral, L., Fernández, S., Marín, J.L. et al, Cerebrospinal fluid composition modifications after neuroendoscopic procedures. Minim Invasive Neurosurg. 2007;50:51–55.
17.El-Dawlatly, A.A. Blood biochemistry following endoscopic third ventriculostomy. Minim Invasive Neurosurg. 2004;47:47–48.
18.Derbent, A., Erşahin, Y., Yurtseven, T., Turhan, T. Hemodynamic and electrolyte changes in patients undergoing neuroendoscopic procedures. Childs Nerv Syst. 2006;22:253–257.
19.Oka, K., Yamamoto, M., Nonaka, T., Tomonaga, M. The significance of artificial cerebrospinal fluid as perfusate and endoneurosurgery. Neurosurgery. 1996;38:733–736.
20.Yamamoto, M., Jimbo, M., Ide, M., Tanaka, N., Umebara, Y., Hagiwara, S. Perioperative antimicrobial prophylaxis in neurosurgery: clinical trial of systemic flomoxef administration and saline containing gentamicin for irrigation. Neurol Med Chir (Tokyo). 1996;36:370–376.
21.Ziai, W.C., Lewin, J.J. Improving the role of intraventricular antimicrobial agents in the management of meningitis. Curr Opin Neurol. 2009;22:277–282.
22.Smith, S.V., Forman, D.T. Laboratory analysis of cerebrospinal fluid. Clin Lab Sci. 1994;7:32–38.
23.Weed, L.H., Wegeforth, P. Experimental irrigation of the subarachnoid space. J Pharmacol Exp Ther. 1919;4:317–334.
24.Hansson E, Vällfors B. A study of irrigation fluids for neurosurgery on brain primary cell cultures. Experientia. 1980 Jan 15;36(1):64-5.
25.Vällfors B, Hansson HA, Belghmaidi M. Mesothelial cell integrity of the subdural and arachnoid surfaces of the cat brain after exposure to neurosurgical irrigation fluids and air: a scanning electron microscopic study.Neurosurgery. 1983 Jan;12(1):35-9.
26.Połubinska A1, Winckiewicz M, Staniszewski R, Breborowicz A, Oreopoulos DG. Time to reconsider saline as the ideal rinsing solution during abdominal surgery.Am J Surg. 2006 Sep;192(3):281-5.
27.Breborowicz A1, Oreopoulos DG. Is normal saline harmful to the peritoneum? Perit Dial Int. 2005 Apr;25 Suppl 4:S67-70.
28.Połubinska A1, Breborowicz A, Staniszewski R, Oreopoulos DG. Normal saline induces oxidative stress in peritoneal mesothelial cells. J Pediatr Surg. 2008 Oct;43(10):1821-6.
29.Shiobara, R., Ohira, T., Onozuka, S., & Kawase, T. (2005). A study on the use of irrigation fluids in neurosurgery. Japanese Journal of Neurosurgery, 14(5), 323-330.
30.Elliot KA, Jasper HH (1949) Physiological salt solutions for brain surgery; studies of local pH and pial vessel reactions to buffered and unbuffered isotonic solutions. J Neurosurg 6: 140-152.
31.Kazim SF1, Enam SA, Shamim MS. Possible detrimental effects of neurosurgical irrigation fluids on neural tissue: an evidence based analysis of various irrigants used in contemporary neurosurgical practice. Int J Surg. 2010;8(8):586-90.