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Neuroanaesthesia: should volatile anaesthetics or total intravenous anaesthesia be used?

The choice of anaesthesia technique for neurosurgical procedures has always been debatable. Despite the well-known effects of volatile anaesthetics on intracranial pressure, these are still widely used. This article explores the advantages and disadvantages of using volatile or total intravenous anaesthesia in patients undergoing neurosurgery.

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There are few outcome studies comparing volatile anaesthetics and total intravenous anaesthesia to facilitate neurosurgery. Volatile gases effectively attenuate surgical stimulation and are neuroprotective; the newer agents such as desflurane promote rapid emergence. Despite this, there are concerns about their effects on intracranial pressure, their use for oncology surgery and their effects on the environment.

Effect of volatile agents and propofol on neurophysiology

Volatile gases cause cerebral vasodilatation, increase cerebral blood flow and therefore blood volume. They are also known to impair cerebral autoregulation in a dose-dependent fashion. However, this effect is minimal when using modern volatile agents at standard concentrations. Cerebral autoregulation is preserved at concentrations of up to 1 MAC (minimum alveolar concentration) with desflurane (Bedforth et al, 2001) and 1.5 MAC with sevoflurane (Juhász et al, 2019). Furthermore, when volatiles are used in combination with opiate drugs such as remifentanil, this has a MAC sparing effect.

Benefits of total intravenous anaesthesia in neurosurgery

Similar to volatile anaesthetics, total intravenous anaesthesia with propofol reduces cerebral metabolic rate, but it preserves cerebral autoregulation at doses up to 300 mcg/kg/min and does not cause significant cerebral vasodilation. This theoretically facilitates better control of intracranial pressure.

A rapid, smooth and coherent emergence from anaesthesia without coughing or vomiting is key to the wake up of neurosurgical patients. It is important to detect early any change in neurology caused by surgery or progression of disease. The most notable benefit of using a propofol–remifentanil combination is smooth emergence. Total intravenous anaesthesia is also of use in an asleep–awake craniotomy, as the patient has to have an early return of cognitive function in order to carry out the tests required to map out pathological areas during surgery. However, a volatile–remifentanil combination can achieve this just as easily with a quicker return to cognition (Lauta et al, 2010).

One clear advantage of total intravenous anaesthesia is the much-reduced incidence of postoperative nausea and vomiting, and the other benefit is the facilitation of intraoperative neuromonitoring. Most anaesthetic agents slow down synaptic transmission but generally volatile gases do this to a larger degree. Inhalational agents cause a dose-dependent decrease in amplitude and increase in latency of evoked potentials (Hasan et al, 2018).

There has been increasing concern about the use of volatile agents in cancer surgeries. The majority of neurosurgeries performed are related to tumours. Propofol preserves immune function and a competent immune system is required to destroy tumour cells. Inhalational anaesthetic agents induce vascular neogenesis in tumour cells by inducing a

hypoxia-inducible factor (Irwin et al, 2020). However, a clinical investigation by Dong et al (2020) on the impact of anaesthesia on long-term outcomes following supratentorial glioma excision showed no significant worsening of overall survival in patients who had sevoflurane as maintenance anaesthesia compared to propofol. They noted that propofol might be of benefit in patients with poor preoperative performance status.

Concerns with using total intravenous anaesthesia

Despite the striking evidence for use of total intravenous anaesthesia in patients undergoing neurosurgery, volatile agents are still used by many. This could be linked to widespread availability and familiarity. Some anaesthetists may worry about the possibility of awareness as there is no quantifiable measure such as inspired volatile concentration to ensure delivery. There are also concerns of a longer time to wake up with propofol following prolonged procedures. The increasing costs associated with setting up of total intravenous anaesthesia, including training, use of depth of anaesthesia monitoring, target-controlled infusion pumps and the plastic waste generated, also remain a concern among anaesthetists (Wong et al, 2018).

Conclusions

Studies have not shown a significant difference in neurological outcomes between volatile and total intravenous anaesthesia. As both are associated with smooth, rapid and coherent emergence, it is difficult to ascertain whether one has clear benefit over the other. However, the added advantages of reduced risk of postoperative nausea and vomiting and the benefit of allowing intraoperative neuromonitoring is likely to make total intravenous anaesthesia the preferred choice among anaesthetists. Increasing awareness of depth of anaesthesia monitoring and familiarisation with the different models and pharmacokinetics of intravenous anaesthetic agents is required to encourage the use of total intravenous anaesthesia in patients undergoing neurosurgery.

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