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How to Control Intra-operative Pain.

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The sympatho-adrenal responses to profound surgical nocistimulation in the presence of inadequate anaesthesia and, or analgesia are undesirable as they elevate blood pressure and heart rate and promote haemorrhage and increase myocardial work. In the presence of pre-existing myocardial disease, systemic hypoxia arising from other causes, and certain anaesthetics, cardiac arrhythmias are likely. Severe nocistimulation in the presence of risk factors may lead to cardiac arrest. If sympatho-adrenal activity has been present for some time, the myocardium may be “exhausted, and resist resuscitation.

Intra-operative nocistimulation can be controlled in four ways: 1) providing pre-operative analgesia; 2) ensure adequate surgical anaesthesia by giving drugs in response to effective anaesthesia “depth” monitoring; 3) treating intra-operative nocifensive reactions as and when they arise; 4) controlling surgical trauma. There are 9 drug classes which are used to control peri-operative pain; these are:

- local anaesthetics
- opioid agonists
- non-steroidal anti-inflammatory drugs (NSAIDs)
- α₂ agonists
- NMDA antagonists
- SAIDs
- benzodiazepines
- antidepressants
- general anaesthetics

Most of these can be incorporated into the former 3 strategies.

Pre-operative analgesia

Pre-anaesthetic medication commonly incorporates analgesics for their sedative, as well as analgesic properties. Opioid drugs and α₂ agonists may be incorporated into pre-anaesthetic medication without complication. NSAIDs may also be given as part of pre-anaesthetic medication, but are commonly given after induction. Newer NSAIDs with low Cox-2 : Cox - 1 IC₅₀ have a moderate to high cost-benefit ratio, but for optimum effect, they should be given pre-emptively. Anaesthesia and surgery increase the toxic potential of NSAIDs, particularly COX-1 inhibitors in several ways, e.g. the concurrent administration of nephrotoxins (methoxyflurane) or inadequate maintenance of renal perfusion. The potential for (nephro- and gastric toxicity) is species dependent: flunixin causes renal damage in hypovolaemic dogs which are hypovolaemic but this is rarely a problem in horses.

Many induction anaesthetics are not analgesic per se, although ketamine-based combinations and those incorporating phenylpiperidine drugs are exceptions.
Once the animal is unconscious, complex and, or invasive local anaesthetic techniques can be employed before surgery begins. These are the most effective defence against intra-operative nociception, but their action may be inadequately prolonged for long operations, unless perineural catheters are used. Extradural opioids provide longer periods of local analgesia for pelvic surgery, but do not relax muscle like local anaesthetics. Any of the nine local anaesthetic techniques can be used to provide analgesia in the conscious or sedated animal, or superimposed upon a ‘light’ level of general anaesthetic, in order to limit the amount of the latter required. Local anaesthetics are an important component of polymodal pain therapy and given pre-emptively, total prevent ‘wind-up’.

Ensuring Adequate General Anaesthesia

The ability to ensure adequate anaesthesia and analgesia during surgery is based on diligent monitoring of “anaesthesia depth”, an appreciation of nocistimulating surgical events, and skills in anaesthesia.

In producing unconsciousness, all anaesthetics produce some degree of analgesia, although the analgesic properties of individual anaesthetics vary. Some amplify the pain experience (cause hyperalgesia) at low plasma concentrations. Progressively increasing doses of anaesthetics that have poor inherent analgesic properties will eventually provide analgesia, other risks will be incurred: a) increased incidence of adverse side effects; prolonged recovery; prolonged duration of side effects

The need to provide adequate analgesia for surgery, while minimising side-effects has long been recognised (Crile 1921; Lundy 1942; Gray and Rees, 1952). ‘Balanced anaesthesia’ has further been refined by polymodal pain therapy (PMPT) and pre-emptive analgesia (PEA).

All inhalant general anaesthetics produce analgesia while unconsciousness is present, but this tends to be poor, and sympatho-adrenal responses are common during invasive surgery when inhalation anaesthetic agents are used alone. This may result in cardiac arrhythmias when halogenated hydrocarbons, e.g. halothane, chloroform, are inspired, although paradoxically, increasing inspired concentrations often eliminates the arrhythmia.

Inhalation anaesthetics cause dose-dependent cardiopulmonary depression. The efficacy : toxicity ratio of different drugs varies, but depends on the side-effect being examined. For example, the apnoeic index (FetIAA at apnoea / MAC) is 2.51 for isoflurane and 2.9 for halothane in dogs which suggests that halothane is the more useful analgesic. However, the cardiac anaesthetic index gives values for isoflurane and halothane of 5.7 and 3.0 respectively - in laboratory rats showing the former to be safer.

Nitrous oxide provides useful analgesia in human beings at concentrations as low as 50% but is less useful in animals in which its MAC value is greater. The agent causes minimal cardiopulmonary depression and has few side-effects when used properly. However, its inclusion in inspired gas mixtures excludes O₂ in a reciprocal fashion and so its cost : benefit ratio higher in large animals, in which the combination of recumbency and general anaesthesia threaten blood oxygenation.

Contemporary veterinary anaesthetic practice has been characterised by partial intravenous anaesthesia (PIVA) in which constant rate infusions (CRIs) of analgesics are used to lower the requirement for general anaesthetics. Drugs may be infused alone, or in combination, although their principal pharmacological requirement is a lack of accumulation. Suitable candidates for PIVA are:

- lidocaine
- ketamine
- phenylpiperidine analgesics
- α₂ agonists (in some species)

Morphine, lidocaine and ketamine infusions (MiLKs) are currently de rigeur, and improve convalescence rates, but have no inherent advantage over alfentanil – ketamine combinations, which make more sense in pharmacokinetic terms.

Treating intra-operative nocistimulation
This may be achieved by deepening anaesthesia, i.e., by increasing vaporizer setting and, or increasing the CRI for delivered analgesic. When a rapid response is necessary, the intravenous injection of analgesic anaesthetic, e.g., ketamine, alfentanil, fentanyl or remifentanil may be necessary, and subsequent measures taken. “Splash” blocks involving local anaesthesia may be useful for persistent recurrence of intra-operative nocistimulation.

Controlling surgical trauma

Aggressive peri-operative analgesic therapy may not prevail against slow surgeons with poor tissue handling skills. These should be encouraged to have surgery themselves, or undergo re-training.

References

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