REVIEW
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THEORY OF MULTIMODAL BALANCED ANAESTHESIA AND ITS PRACTICE

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INTRODUCTION

Multimodal balanced anaesthesia is a technique of general anaesthesia based on the concept that administration of a mixture of small amounts of several neuronal depressants summates the advantages but not the disadvantages of the individual components of the mixture (Wolfensberger and Larenza, 2007). This will ensure achievement of analgesia, unconsciousness and muscle relaxation. Use of several agents at small doses maximizes desired effects but minimizes their side effects. A rational strategy to achieve this multimodal balanced approach is to administer drugs that directly maintain the anaesthetic state (analgesia/unconsciousness/immobility) and those that indirectly contribute to its maintenance.

Multimodal balanced anaesthetic practice, works on the basis of control of nociception. The difference in nociception and pain, and the concept of multimodal approach in managing nociception, needs description before going into details. Propagation of potentially noxious and harmful stimuli through the sensory system is called nociception. On the other hand, pain is the conscious perception of the nociceptive information. To describe more, consider an animal unconscious under propofol alone, and being operated. The heart rate and BP would be seen increasing upon surgical stimulation. This means there is nociception. But pain include instances where a surgeon makes an incision on insufficient local/field block in a cow/dog, and the patient (cow) gives a kick to the surgeon, or the dog turns and bites the surgeon.

Presence of multiple and different neurotransmitters and neuronal transmissions in the afferent and efferent pain pathways, provides multiple targets where antinociceptive drugs can act to block the nociceptive propagation and processing of nociceptive information. Simultaneous targeting in the nociceptive pathway system is the main concept associated with the planning of a multimodal approach for nociceptive control and thus multimodal general anaesthesia. Also, arousal pathways are strongly connected with the nociceptive pathways. Hence, antinociception decreases

arousal. Antinociception has to be maintained during general anaesthesia by simultaneously using multiple anti-nociceptive drugs. Each drug should target each component of the nociceptive system, so as to completely inhibit transmission of nociception. The hypnotic drugs used for unconsciousness, indirectly contribute to antinociception by reducing the ability to perceive pain. Sedatives will tremendously reduce the requirement of the drugs needed for inducing and maintaining the unconciousness by inhibiting arousal due to nociception. Combining these drugs causes reduction in the use of drugs for induction and maintenance, hence facilitating faster recovery. Immobility can be achieved and maintained through muscle relaxation by using a muscle relaxant or drugs providing muscle relaxation, which also decrease arousal.

To cite as examples, ketamine, fentanyl, dexmedetomidine, lignocaine and NSAIDs directly maintain the state of antinociception, while propofol, isoflurane, sevoflurane and etomidate reduce the ability of nociception and thereby indirectly contribute to antinociception. Propofol, isoflurane, sevoflurane and etomidate directly maintain the state of unconsciousness, while ketamine, fentanyl and dexmedetomidine indirectly contribute to unconsciousness by inhibiting nociception induced arousal. Atracurium, cisatracurium, rocuronium and midazolam directly maintain immobility through muscle relaxation, while propofol, isoflurane, sevoflurane and etomidate contribute to muscle relaxation by blocking the neurons at level of spinal cord.

Practical approach to multimodal balanced general anaesthesia

Premedicate the patients as part of general anaesthetic procedure. This provides chemical restraint, reduces anxiety in the animal resulting in calming down or even sedation, thereby reduces total dose of drugs required for anesthetic induction and maintenance. Provide pre-emptive analgesia using an analgesic drug like NSAID. Pre-emptive analgesia is an antinociceptive treatment that prevents establishment of altered processing of afferent input, which amplifies postoperative pain. It is the analgesic treatment initiated prior to surgery.

Following pre-emptive analgesia and sedation using combination of various premedicant drugs, which induce general anaesthesia with intravenous induction agents. Propofol, thiopentone sodium, etomidate and ketamine are the commonly used induction agents. Induction agents are commonly given intravenously. The depth of sedation achieved with the premedicant drug combination would help reduce the drug required for induction of general anaesthesia, and even that required for maintenance. Thus, multi-drug anaesthesia uses a combination of drugs to induce and maintain anaesthesia in a patient. This approach summates the effects, but

minimizes the side effects. Line block or regional nerve block would inhibit transmission of nociception induced during surgical incisions and manipulations, and thereby decreases arousal. Continuous rate infusion (CRI) of dexmedetomidine or ketamine or a combination of both would sustain the plasma levels of the drugs required for maintaining control of nociception. Apart from helping decrease arousal, the CRI decreases requirement of drugs needed for maintenance of unconsciousness.

Maintain unconsciousness with low percentage of isoflurane or sevoflurane in oxygen MAC requirement of isoflurane /sevoflurane for maintenance of unconsciousness will be reduced by 60-70% when such balanced approach is followed. Administration of dexmedetomidine, ketamine, midazolam and lignocaine combination as CRI, also would maintain unconsciousness, apart from providing sustained control of nociception, for majority of moderately painful surgical procedures.

Protocol 1:

Premedication – Give meloxicam (targeting the cyclo-oxygenase pain pathway) 30 to 45 minutes prior (considering the time taken for its peak effects) to the proposed time for surgery and followed 20 minutes later, by xylazine or dexmedetomidine plus butorphanol or buprenorphine or fentanyl or nalbuphine. (Lower doses of xylazine and dexmedetomidine is used when combining with the opioids. Xylazine /dexmedetomidine provides analgesia by activating the inhibitory neurons and inhibit nociceptive transmission. They also decrease arousal by reducing release of norepinephrine. Opioids, through the opioid receptors, inhibit nociceptive transmission and provide analgesia. This combination of an alpha 2 adrenoceptor agonist and an opioid provide good sedation).

Induction of anaesthesia / unconsciousness –

Effect unconsciousness by intravenous administration of midazolam or diazepam immediately followed by intravenous administration of either propofol or ketamine or etomidate or thiopentone, or a combination of propofol and ketamine.

Intravenous administration of midazolam/diazepam, just prior to induction, would help to reduce the dose of the induction drugs than their routine doses. As the undesired effects / side effects of the induction drugs are always dose dependent, lowering their doses will help to reduce the unwanted effects manifested during anaesthesia. But unconsciousness could still be achieved because of the profound sedation provided by the combination of premedicants given.

Sustain antinociception - Effect conduction block by using lignocaine at site of surgical

incision, as line block or as regional nerve block could help to sustain the antinociception. Administration of dexmedetomidine or ketamine or a combination of both as CRI (at their analgesic CRI doses) will also help the maintenance of antinociception.

Maintenance of unconsciousness

Maintain unconsciousness with low percentage of isoflurane or sevoflurane in oxygen. MAC requirement of isoflurane/sevoflurane for maintenance of unconsciousness will be reduced by 60-70% when such balanced approach is followed. Administration of dexmedetomidine, ketamine, midazolam and lignocaine combination as CRI, also would maintain unconsciousness.

***Protocol 2*:**

Premedication

Give meloxicam (targeting the cyclo-oxygenase pain pathway) 30 to 45 minutes prior (considering the time taken for its peak effects) to the proposed time for surgery. Followed 20 minutes later by acepromazine plus butorphanol.

Acepromazine in combination with an opioid proved to provide a good sedation and an excellent neuroleptanalgesia.

Give midazolam immediately before administration of the induction agent. This would further reduce the requirement of the induction agent to effect unconsciousness by increasing muscle relaxation.

Induction of anaesthesia / unconsciousness

Effect unconsciousness by intravenous administration of either propofol or ketamine or etomidate or thiopentone, or a combination of propofol and ketamine.

Sustain antinociception

Effect conduction block by using lignocaine at site of surgical incision, as line block or as regional nerve block. Give Buprenorphine 20 minutes after the start of surgical procedure, which prolongs the analgesia for 6-8 hours because of its long plasma half-life.

Maintenance of unconsciousness

Administer optimum percentage of isoflurane or sevoflurane in oxygen. Dexmedetomidine or ketamine can be given at analgesic doses as injectable boli in case of increased nociception.

As a conclusion, it should be kept in mind that all undesired effects of anaesthetic drugs are dose dependent. Administering small amounts of several drugs, each with specific action on nervous system to achieve individual states of general anaesthesia, and sustaining the states with maintenance of the plasma levels of the respective drugs needed for the same would maximise the desired effects and minimises the side effects. Multimodal balanced approach provides smooth induction and maintenance, fast recovery and stable physiological states. This would be a more ideal approach for general anaesthesia in small animal practice.

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