



Ketamine in Anaesthetic Practice

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Consider the following real life cases and how you might manage them:

Case 1

A 22 year old man has been admitted with a gunshot wound to the abdomen. He is shocked from major internal bleeding and requires a laparotomy. You have a very small supply of inotropes and want to try and not use them. What will you do for induction and maintenance of anaesthesia?

Case 2

A 2 year old boy needs repair of his hernia. He is extremely frightened of the hospital and its staff. You think that obtaining intravenous access will be very difficult and that a gas induction will be difficult as well because of his agitation. How will you anaesthetise this child.

Case 3

A 37 year old woman is recovering from 45% burns, she needs dressing changes every two days which are very painful. She has very few sites left for i.v. access and you don't want to use them as she has further surgery to come. She is also very scared of needles. How will you manage the sedation she requires for her dressing changes?

Case 4

Your laparotomy patient (case 1) is back on the ward. He has severe postoperative pain but you have been unable to get any morphine this month. How can you manage his postoperative pain?

Case 5

A 25 year old man has had his leg amputated after a motorbike accident. He is suffering from lots of problems with phantom limb pain. You have tried giving him amitriptyline and carbamazepine but without effect. What could be your third line option?

Case 6

An 18 year old girl has been admitted with severe asthma. You have been asked to see her as she has not improved with subcutaneous injections of salbutamol or intravenous aminophylline. She is getting tired and her oxygen saturation is falling. Can you do anything to help?

Introduction

Ketamine is the only anaesthetic available which has analgesic (pain relieving), hypnotic (sleep producing) and amnesic (short term memory loss) effects. When used correctly it is a very useful and versatile drug.

Ketamine is available in three different concentrations 10mg/ml, 50mg/ml and 100mg/ml. 50mg/ml is most commonly stocked since it can be used for i.m. administration or diluted for i.v. use.

Routes of Administration

Ketamine may be given intravenously (induction 1-2mg/kg, maintenance 0.5mg/kg) or intramuscularly (induction 5-10mg/kg, maintenance 3-5mg/kg) for anaesthesia or orally (15mg/kg for a child to a maximum of 500mg for an adult) for sedation.

Effects of Ketamine on the Body

Respiratory System

With ketamine the airway is usually well maintained it also preserves the laryngeal and pharyngeal reflexes to some degree. This is not always guaranteed however and standard techniques, where required, for prevention of aspiration and maintenance of a patent airway must be used. When ketamine is given slowly respiration is usually well maintained, after rapid i.v. injection the breathing may stop for a short while but usually restarts within a minute. For this reason ketamine is a very useful anaesthetic agent in areas where there is no oxygen or only limited oxygen available. Ketamine is an effective bronchodilator.

Cardiovascular System

With ketamine there is an increase in both blood pressure and heart rate. This usually reaches a maximum about 2 minutes after injection and settles over 15 –

20 minutes. There is wide variation in individual response and occasionally there can be a large rise in blood pressure. The risk of this is not related to a preoperative history of hypertension. This rise in blood pressure usually responds to further doses of i.v. diazepam (1-2mg for an adult).

This increased workload for the heart means that ketamine should be avoided, if possible, in those patients with ischaemic heart disease. Patients with diabetes should have an ECG, if available, to rule out "silent" ischaemia (ischaemia without chest pain), since this is a common feature of poorly controlled diabetes.

Central Nervous System

Ketamine produces dissociative anaesthesia (detached from surroundings). This means that unlike with other anaesthetic agents the patient may have their eyes open and make reflex movements during the operation. It has a slower onset after an i.v. bolus (1-5 minutes). The duration of action depends on the route of administration (20-30 minutes for i.m. and 10-15 minutes for iv).

Ketamine provides very good analgesia and may be used without any other analgesics intraoperatively. Consideration does then have to be given however to postoperative pain relief. Co-administration of opiates or tramadol intraoperatively can reduce the amount of ketamine required for maintenance of anaesthesia and therefore reduce the incidence and duration of postoperative hallucinations. This does however increase the risk of the breathing stopping during the operation.

In recovery the patient may be agitated – this is due to the frequent occurrence of hallucinations after ketamine anaesthesia. These hallucinations can be reduced by premedication with benzodiazepines (usually diazepam 0.15mg/kg orally 1 hour preoperatively or 0.1mg/kg) and by recovering the patient in a quiet area.

Ketamine increases the intracranial pressure and for this reason should be avoided wherever possible in those patients with recent head injuries.

Gastrointestinal Tract

Ketamine increases salivation. This can lead to airway problems due to laryngeal spasm or obstruction. It may also make the taping of endotracheal tubes more difficult. To reduce this salivation atropine is usually given either as a premed (20mcg/kg i.m.) 30 minutes preoperatively, or at the time of induction iv (10-20mcg/kg).

Skeletal Muscle

Ketamine increases skeletal muscle tone. This is most prominent after the initial iv bolus and gradually decreases. It is improved by administration of benzodiazepines. It is rarely a problem intraoperatively.

Eyes

Ketamine increases intraocular pressure. The eyes also commonly move continually during ketamine anaesthesia (nystagmus). This makes it an unsuitable anaesthetic for eye surgery.

Placenta

Ketamine crosses the placenta. Newborn infants after caesarean section under ketamine anaesthesia will therefore be partially anaesthetised and should be cared for accordingly.

Some Practical Examples:

Case 1: IV ketamine for induction and maintenance

This gunshot victim is shocked and requires a laparotomy, you have limited inotropes. Ketamine would be an ideal anaesthetic agent in this case due to its cardiovascular effects of raising the blood pressure and heart rate, all other anaesthetic agents tend to have a cardiac depressant effect.

Induction can be performed with iv ketamine (1-2mg/kg), atropine (10-20mcg/kg) and diazepam (0.1mg/kg). It is still possible to perform a modified rapid sequence intubation with ketamine, despite its slower onset time.

There are several options for maintenance:

- 1) intermittent boluses of iv ketamine (0.5mg/kg) given according to patient's response - pupil size, heart rate, blood pressure, movement etc
- 2) ketamine infusion. Put 500mg of ketamine in a 500ml bag of saline or dextrose. Run this at 1-2mls/min (1-2mg/min). Some patients may require more and others less depending on what other drugs have been given and the type of surgery.

Generally the ketamine will need to be discontinued 20-30 minutes before the end of the operation to avoid a long wait for the patient to wake up.

This technique for laparotomy is best used with non-depolarising muscle relaxants (avoid pancuronium as combined with ketamine may have very high

blood pressure increases). It is however possible, although more difficult, to perform the laparotomy under ketamine alone.

Case 2: use of i.m. ketamine

This child is clearly going to be uncooperative and either i.v. access or gas induction will be difficult. In these circumstances intramuscular ketamine is very useful.

There are two possible options:

- 1) induce anaesthesia with i.m. ketamine (5-10mg/kg) + atropine (20mcg/kg) + diazepam (0.1mg/kg) these may all be mixed in the same syringe. Onset of anaesthesia will start about 5 minutes after injection. The disadvantage of this technique is that it requires a relatively large i.m. injection. While most textbooks quote 8-10mg/kg for induction it has been my experience that in many cases a much smaller dose (5mg/kg) is sufficient.
- 2) sedate with i.m. ketamine (2mg/kg) + atropine (20mcg/kg) + diazepam (0.1mg/kg). After 5 minutes you will have a docile child who can cooperate with either cannulations or a gas induction.

The author's preference is for option 2 since the i.m. injection is smaller and it can be performed safely in the waiting area on the mothers lap rather than in theatre and is therefore less traumatic.

In either case iv access should then be obtained. If iv access is impossible then anaesthesia can be maintained with i.m. ketamine (3-5mg/kg).

Case 3: oral ketamine sedation

This woman requires recurrent sedation for painful burns dressings. IV ketamine is possible but in burns patients there are often limited sites for cannulation and these are best saved for trips to theatre. IM ketamine is also an option but requires relatively large painful i.m. injections. Instead the intravenous preparation of ketamine can be given orally.

For an adult give 500mg of ketamine + diazepam 5mg.

For a child use 15mg/kg ketamine + 0.2mg/kg diazepam (you can use the i.v. preparation but it tastes very bad and may have to be hidden in juice).

The dressing change can usually start after 20-30 minutes. Responses can sometimes be unpredictable and onset time may be slower. There should always be equipment for suction and face mask ventilation available and if possible, oxygen and a pulse oximeter.

Case 4: ketamine for postoperative analgesia

Ketamine is a very good analgesic and can be a solution for severe pain when morphine is not available. Its use postoperatively is limited by the occurrence of hallucinations, however these are less of a problem when relatively low doses are used. For adult patients in severe pain a loading dose of 0.5-1 mg/kg i.m. may be given. This can then be followed by an infusion of 60-180mcg/kg/hr (4-12 mg/hr for a 70kg adult).

A reasonable regime is to put 50mg ketamine in a 500ml bag of saline or dextrose (0.1mg/ml of ketamine) and run this at 40-120mls/hr (i.e. over 4-12 hours for a 70kg adult). This regime is relatively safe since even if the whole infusion were to be given quickly by accident the patient is unlikely to become deeply anaesthetised but the patient should still be closely monitored and anaesthetic help should be available if needed.

Case 5: use of ketamine for patients with chronic pain

Many patients with amputations or patients with spinal cord injuries have problems with chronic pain. The nature of this pain is often neuropathic (this means originating from an injury to the nerves) and has an unpleasant burning or shooting quality to it. When traditional first line treatments for neuropathic pain such as amitriptyline or carbamazepine have failed ketamine may also be added and has been shown to have success.

A standard dosing regime for an adult is 50mg orally (use the intravenous preparation) three times per day. This may be increased to 100mg tds. Problems with hallucinations and salivation are rare. The ketamine may be discontinued after about 3 weeks of good pain control, reducing the dose gradually to see if any pain symptoms reoccur. The authors have found this regime useful in postoperative amputation patients to try and prevent the onset of phantom limb pain. In this setting it seems the ketamine need only to be taken for about a week.

Case 6: ketamine for the treatment of asthma

Ketamine is an effective bronchodilator and can be used for the patient who is not responding to conventional bronchodilators such as salbutamol and aminophylline. The doses of ketamine required are very low and problems with hallucinations rare. A loading dose of 0.2 mg/kg iv is given initially followed by an infusion of 0.5mg/kg/hr for 3 hours. This may be continued if necessary. Close monitoring of the patient is required and an anaesthetist should be available if necessary.

