EXTRADURAL ANAESTHESIA IN THE PIG

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SUMMARY

A safe technique for the premedication and extradural anaesthesia of experimental pigs is described. A method of superior vena caval cannulation used in these laboratories is also described. The anaesthetic technique allows abdominal operations to be carried out on pigs without the disadvantages of general anaesthesia.

The purpose of this paper is to describe a technique of anaesthesia which has been entirely satisfactory for surgery in thirty consecutive pigs; during this series no mortality has occurred and it has been the most efficient method so far used.

When our renal research programme was begun four years ago it was decided to use pigs. This choice was made because (a) they do not suffer, as do dogs, from chronic nephritis; (b) the kidney structurally resembles that of man and is of adequate size for surgical procedures. Fusion of the metanephric elements is not complete. This means that one can distinguish the cortex and medulla very easily during the operation. Also, the lobular pattern is quite distinct, each lobule being easily recognizable even at operation.

Anaesthesia appeared to be a great problem because pentobarbitone, chloral hydrate, ether, nitrous oxide and oxygen with thiopentone induction had all been tried and each method was shown to have serious disadvantages. It appeared that the ideal anaesthetic for experiments involving renal function would provide freedom from any effects of the drug on the kidneys, good relaxation to ensure an easy retroperitoneal approach, a conscious yet quiet animal, safety and ease of administration in a single dose, and easy access to the superior vena cava to permit intravenous administration of fluids, which in the pig is difficult to achieve through the peripheral veins.

For this reason the author and his colleagues attempted to develop an epidural anaesthetic technique which would be used routinely in all experiments and which would require the minimum time to induce.

METHODS AND RESULTS

Pigs weighing 25–35 kg are used. Chlorpromazine 50–75 mg (25 mg/ml) and pentobarbitone 120–180 mg are given intramuscularly 20 minutes before operation. The premedication has an effect within 10 minutes and the pig becomes easy to handle and very sleepy. This combination of drugs appears to be safe and reliable, and there is little variation in response to it. The animal is then taken in a mobile cage (or hessian sack if the pig is small enough) to the anaesthetic room next to the operating theatre.

Here sodium pentobarbitone 120–240 mg is introduced intravenously into a marginal ear vein (fig. 1) to the point of sleepiness. Following this,
an epidural anaesthetic is given, using a 24-inch (6.5 cm) 19-gauge needle, standard bore with a short bevel, fitted to a 10-ml syringe; 8 ml of 2 per cent plain lignocaine is injected into the epidural space through the lumbosacral space. To do this the animal is restrained on its side with its hind limbs flexed. The spinal cord ends at the junction of the 5th and 6th vertebrae and the meninges continue as far back as the middle of the sacrum, the lumbosacral space being relatively large. The lumbosacral space is posterior to the iliac crests which are easily felt (fig. 2); the needle is directed in the midline at an angle of 75 degrees to the skin. Loss of resistance to injection is the best criterion for locating the epidural space, although it is important to aspirate in order to ensure that the needle is not in the subarachnoid space. It is not easy to detect any separate regions of resistance when inserting the needle into the epidural space. The supraspinous ligament is difficult to pierce, but once through this structure the usual sensation, present in man, of piercing the ligamentum flavum is absent. Aspiration having determined the absence of cerebrospinal fluid, the injection is made slowly over a period of about 3 minutes. A catheter is not normally inserted into the epidural space. As the lignocaine is slowly injected its effects are first seen by the twitching of the tail and muscles of the hind limbs. Paralysis of the lower abdomen and limbs comes on a minute or two later. The analgesia lasts for about 90 minutes and during this time complete relaxation and absolute loss of sensation is obtained. The area of sensory loss extends from the last rib caudally including the loin, hind limbs and ventral abdomen.

For operation the animal is placed on its back or side, depending upon the surgical approach, both hind limbs being tied to the table. The chest is supported by sandbags on the sides if the pig is on its back. For intravenous infusions the superior vena cava is catheterized. This is done by extending the animal's head as much as possible on the table. Lignocaine (5 ml of 1 per cent) is infiltrated under the skin just anterior to the sternum. The anterior end of the sternum and the trachea are palpated. The superior vena cava is just ventral to the trachea in the anterior mediastinum (fig. 3). An 8-cm 19-gauge needle passes between the trachea and sternomastoid muscle directly backwards at an angle of 60–70 degrees (fig. 4). The superior vena cava is quite thickwalled and a definite “popping” sensation is detected when it is punctured. It is necessary to have the syringe attached to the needle, for if the animal suddenly inspires, air embolism and death is likely to occur. In fact, the only death using this method of anaesthesia occurred as a result of air embolism induced in this way, and this happened during the developmental stage of the technique.

There were no intracervical or thoracic complications following vena caval catheterization and, although there is a possibility of damage to the left phrenic nerve, so far this has not occurred. The needle can be left in place or a polyvinyl
Fig. 3

The neck and chest have been opened in the sagittal plane ventrally. The following structures are seen:

(a) Sternomastoid  (d) Superior vena cava
(b) Trachea       (e) Sternum
(c) Bicarotid trunk (f) Heart
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Here the surface anatomy is related to the underlying structures in the schematic diagram. The needle is directed towards the superior vena cava.

catheter inserted. A further small dose of pentobarbitone sodium can be given through the cannula into the superior vena cava.

A dose of 60–120 mg of pentobarbitone may be given once or twice during an hour-long operation. During this time the animal is lightly asleep. It has a strong corneal reflex and will resist interference about the head or neck. The area of anaesthesia, on the other hand, is fully relaxed and immobile. The anaesthetic can be relied upon for 90 minutes; beyond this time sensation begins to reappear. No attempt should be made to restrain the forelimbs, as in this method of anaesthesia, given this freedom of movement, the animal remains calm and unexcited.

Following the operation, the pig is kept in a warm room at a temperature of about 80°F until it can stand again. Few pigs miss a meal following even a major renal operation, and we have had no postanaesthetic paralysis, meningeal infections, or pulmonary infections. Operations have been performed on thirty consecutive pigs, using the method of anaesthesia described. In every case analgesia has been profound, relaxation ideal, and the postoperative state of the animals has been good. There has been no morbidity following even major renal operations.

DISCUSSION

The anaesthetic technique described is superior to inhalation anaesthesia with open ether because of its safety and ease of administration. The writer has found that during ether anaesthesia in pigs, sudden death is likely to occur. This is due to cardiac irregularities leading to arrest. On the occasions when sudden collapse has occurred, efforts at resuscitation have been generally unsuccessful.

In this method, having given the anaesthetic, the anaesthetist is freed for other tasks during the experiment. Another advantage is that there are no pulmonary problems as there are with inhalant anaesthetics generally in pigs. These animals are notoriously susceptible to postanaesthetic respiratory infections, which are due to both bacterial and parasitic causes. The bacteria concerned are Pasteurellae, erysipellothrix, and mixed infections. The principal parasitic causes of pneumonia in pigs are the larval stages of ascaris lumbricoides var suis. The method described removes a large part of the risk of morbidity.

There is no doubt that endotracheal anaesthesia is reasonably satisfactory in pigs. On the other hand, special intubation equipment is required, the anaesthetist is required for the whole of the operation time, and the postanaesthetic respiratory complications are not entirely avoided by intubation.

Some years ago chloral hydrate became popular when used by the intraperitoneal approach. This is an irritant drug and in the author’s experience occasional cases of peritonitis follow its usage. Great variation in response due to variation in rate of absorption is another serious disadvantage to intraperitoneal chloral hydrate. It also takes some 15–20 minutes for the drug to have its effect, and this is a drawback when a large amount of experimental work is being contemplated.
The advantages of this method of anaesthesia over the others that have been found are: ease of administration; reliability of effect; that anaesthesia requires only a short time to induce; there are no peritoneal or pulmonary complications; and recovery is quick and complete.

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