Intravenous Anesthesia and Tracheotomy in the Experimental Animal-Cat

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(Received October 12, 1971)

Nowadays, there are a large number of animal experiments, either for professional or pre-professional (included only for training) at various laboratories. These are, of course, performed for the purpose of advancing the human's culture and health. As described in articles (1, 2, and 3) by the Council of The American Physiological Society and by JAMA, we have to pay careful and thoughtful attention in doing the animal experiments, including the humane handlings. The purpose of this paper is to make some description of our ideas and technique for the intravenous anesthesia and the tracheotomy in the cat in order to avoid an unnecessary and noisy struggle in the laboratory with the poor experimental animals during the anesthesia, to avoid an unnecessary and bothersome hemorrhage and some following tracheal edema due to the tracheotomy; and also, in order to concentrate our thoughts to the experimental purpose on a higher level.

INTRAVENOUS ANESTHESIA

Only because of difficulty in restraining cats for intravenous injection, some investigators prefer to anesthetize the cats by injecting a barbiturate or thiobarbiturate intrathoracically. But, other investigators strongly opposed intrathoracic administration of anesthetic to the animal, stating there is bound to be some risk to the heart, pericardium and the lung. In fact, we have several cases which suddenly died due to haemothorax, and haemocardium. These were noticed by necropsy. Our other cases which died were presumed that the cause of death was probably respiratory arrest due to uncontrolable anesthetic injection intrathoracically. With intrathoracic and intraperitoneal administration, control is difficult since precalculated dose must be given.

In a cat, we prefer that the saphenous vein on the inner surface of the hind limb, and also the saphenous vein on the lateral surface of the hind limb is used with large benefit for intravenous anesthesia in our experiments.

The femoral vein on the inner surface of the thigh is the third choice. We should like to keep the femoral vein intact for "Intracath" indwelling and additional

anesthetic shot, and for the injection of the agents in a drug test.

In our laboratory we do not use any commercial restraining cage or box for the cat anesthesia. We made a carrying box with the round holes on the wall of the box (Fig. I-1). This small hole is convenient for the purpose of the intravenous injection of an anesthetic. Usually, we grasp the right hind limb of the cat and push the paw out through the hole. Pulling it out and grasping the paw fairly tight but not strongly with the anesthetist's or the assistant's left hand, the hair over the saphenous (both inner and lateral) veins and also, if possible, over the femoral vein of the thigh is removed with an electric clipper (Fig. I-2).

The skin is prepared by swabbing with a suitable antiseptic. This procedure, in addition to cleaning the area, tends to distend the vein for venesection. If the vein is not easily seen, by rapidly squeezing the paw several times pumps blood from the paw to distend the vein. The assistant sometimes can compress the saphenous and femoral vein at the proximal portion.

Along the engorged vein, a shallow incision is made on the skin over the vein (Fig. I-3) using with a nicely sharp round point knife (Blade #10), cutting lightly the skin and subcutaneous tissue, and perivascular loose connective tissue, but not touch the vein.

The exposed and engorged vein is directly seen in the incision wound. (Fig. I-4). The intravenous anesthetic solution is sucked in a 5 cc. syringe. The usual dose of Pentobarbital and Pentothal are a 30 mg/kg. and 25 mg/kg. B. W. in cat, respectively.

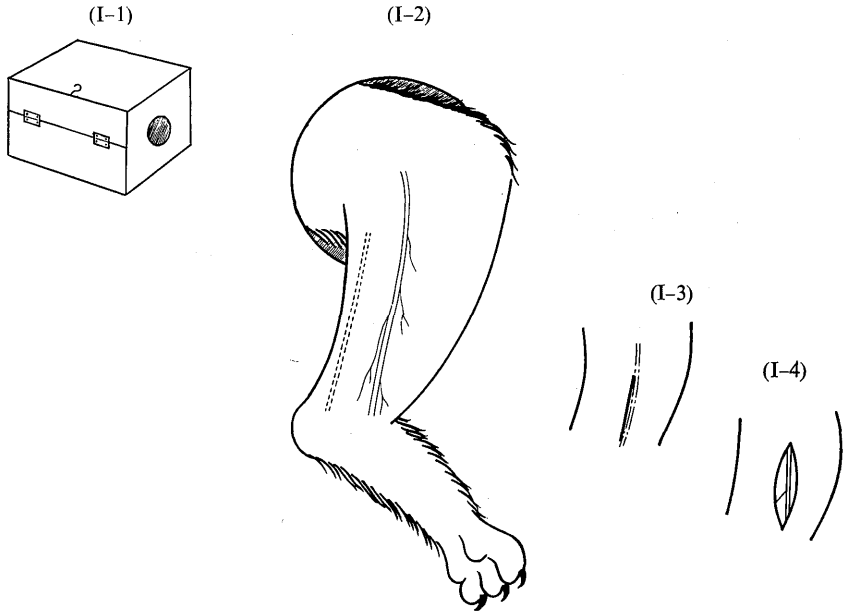
Good technique demands that the needle used for injection be threaded up the vein so that the hub is at the site of venipuncture. The leg and syringe are both held in the left hand during injection so they will move as a unit if the cat moves. This prevents accidental retraction of the needle from the vein.

The injection should be made toward the distal end of the vein so that if the first attempt is unsuccessful another may be made more proximal. A 24–25 gauge needle is inserted with the bevel upward and is threaded up the vein for 4 or 5 mm.

The anesthetic is injected slowly. After air bubbles may be seen traveling up the vein as injection is started; this assures the needle is in the lumen and is not of any particular danger to the animal.

During injection the respirations should be carefully observed. If the respirations become fewer than ten respirations per minute it should be the cause of grave concern. Some of the small and thin cats are very difficult to anesthetize to a satisfactory depth of anesthesia with intravenous pentothal. This is because there is a very small margin of safety between the surgical anesthetic dose and one causing respiratory arrest. The first one-third to one-half of the dose is relatively rapidly but for not less than 15-20 second period injected while the anesthetist and the assistant watch the animal's posture.

Fig. I. Intravenous anesthesia procedure.



I-1. Animal box with a hole.
I-2. Pulling out and hold the right hindlimb through the hole. Outline of the saphenous vein.
I-3. Skin incision along the vein after clipping the hair.
I-4. Exposure of the saphenous vein and I. V. injection.

As injection is continued, when the pedal reflex is abolished the animal is in the state of surgical anesthesia. Now we did it satisfactorily. ("Intracath" indwelling) As usual way, "Intracath" was inserted and indwelled through the exposed vein, easily.

TRACHEOTOMY

After getting the sufficient state of surgical anesthesia, the cat is placed in the usual way on the fixation apparatus. The cat lay on her back hyperextending her head and neck to make a good look of surface anatomy landmark. The surface anatomy landmark from above downward are the thyroid cartilage prominence and the cricoid cartilage notch, and partly tracheal contour (Fig. II-1).

The operator places his left index and middle fingers along the tracheal contour, and presses expanding the skin to be incised (Fig. II-2).

The vertical incision is made shallow to cut the skin and subcutaneous tissue including the pre-tracheal muscles and the pre-tracheal fascia (Fig. II-3). The pre-

tracheal fascia will be incised at the level of the cricoid cartilage, or the lower part of the thyroid cartilage. At this point, we should avoid making an unnecessary long incision of the pretracheal fascia extended beneath the cricoid cartilage level since such an incision will dissect the vessel crossing the tracheal anterior surface and produce rather bothersome hemorrhage (Fig. II-4).

But we have to make exact exposure of the tracheal wall. The operator still keeps his fingers along the tracheal contour while expanding the skin. Now, as shown in Fig. II-5, the tip of the small curved hemostat is inserted into the incision wound, touching the cricoid cartilage and the exposed tracheal wall and is opened with the right hand. The left hand is released from the pressing of the skin and holds another curved hemostat. The tip of the larger curved hemostat in the left hand is inserted in the wound which is opened by the small curved hemostat (Fig. II-6).

Three or four separation movements using these two curved hemostats is always enough to separate the loose connective tissue surrounding the trachea (Fig. II-7 and II-8).

The tip of small curved hemostat is inserted beneath the trachea and used to pull the suture silk (Fig. II-9 and II-10). The middle of the suture silk is cut and the ends are cramped with two hemostats. The reversed T-shape incision of the tracheal wall is made including the transverse incision in the tracheal ring cartilage (Fig. II-12) (which makes relatively strong margin of the wound and, what's more, less bleeding from the tracheal wall).

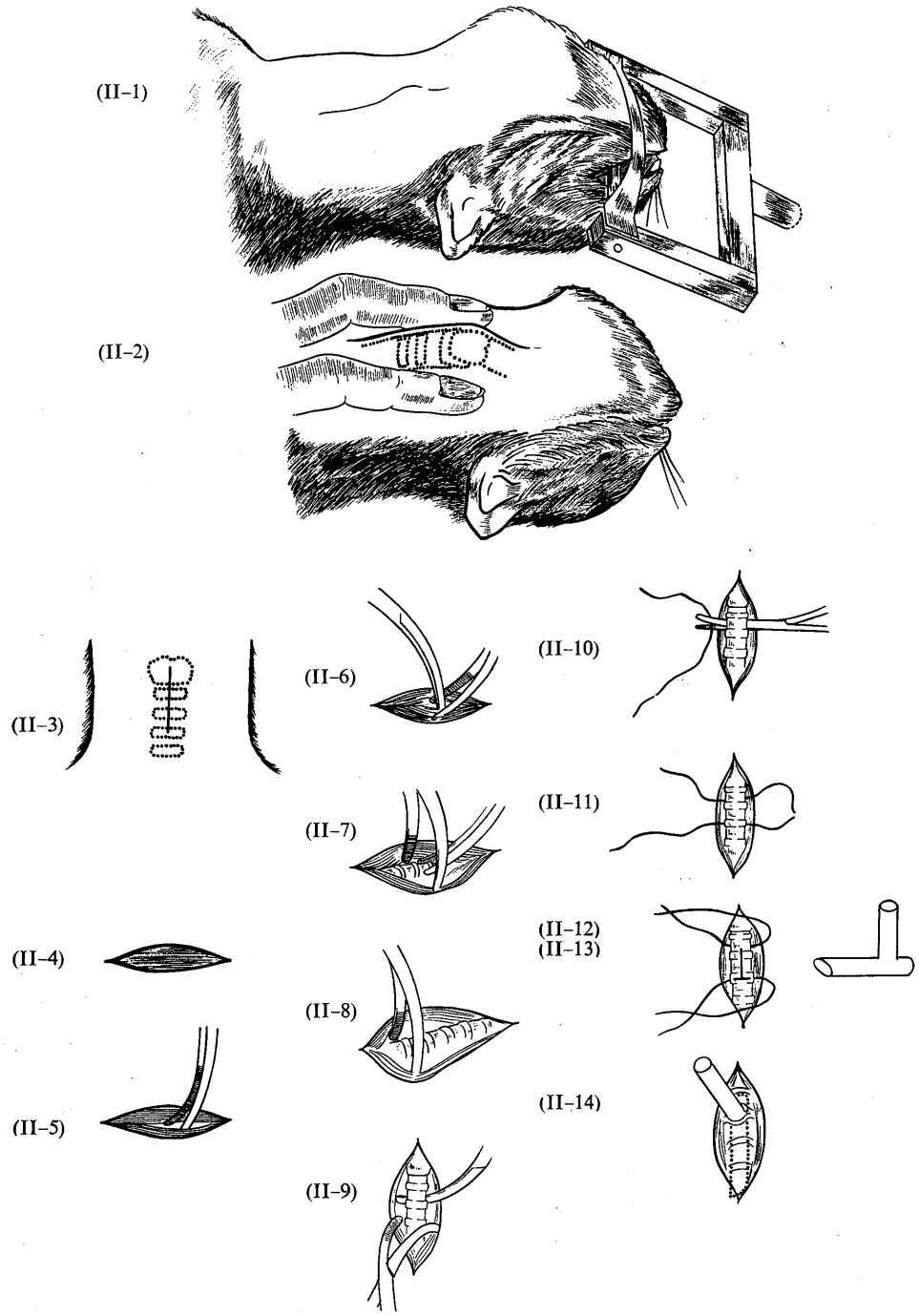
After the gentle insertion of the tracheal canula, the technique of instrument tie is applied to fix the canula (Fig. II-13 and II-14).

This procedure has to be performed gently with intensive care to avoid any unnecessary bleeding from the operation wound and also to avoid the tracheal edema and excessive secretion therein.

After all, we also must ascertain to maintain the good passage of the air in the canula and trachea.

Fig. II II- 1. Restraining the cat.
II- 2. Palpation and holding the tracheal contour.
II- 3. Skin incision.
II- 4. Opening the incision wound.
II- 5. Separation.
II- 6. Separate the connective tissue using with two small curved hemostats.
II- 7. Expose the trachea.
II- 8. Complete the exposure of the trachea around.
II- 9. Insert the tip of a curved hemostats beneath the trachea.
II-10～11. Suture line.
II-12. Incision of the tracheal wall.
II-13. Tracheal canula.
II-14. Insertion of the canula.

Fig. II. Tracheotomy procedure (see the text).



ANESTHETIC EMERGENCY

Needless to say, effective anesthesia is that which obliterates the patient's response to painful stimuli without depressing vital function.

The depth of anesthesia is however altered individually with marked variations in response to a standard dose of anesthetic. So, some of the small experimental animals react to even the usual dose by the usual procedure, showing the depression of the vital function.

There are many factors and causes altering the depth of anesthesia ; such as :

1. Relative size
2. Physical condition
3. Age
4. Sex
5. Latent-concurrent disease

Another cause is a drug itself, especially in Pentothal anesthesia, showing a very small margin of safety between the surgical anesthetic dose and one causing respiratory arrest.

In daily laboratory experiments most of the investigators have bitter experiences in letting the valuable animals die. The death of the experimental animals means a loss of money, time, and the delay of research progress.

Since Pentobarbital (Nembutal) and Thiopenthal (Pentothal) are most frequently and popularly used for the cat anesthesia in the laboratories and since we encountered, not infrequently, the anesthetic emergencies with these drugs, we should like to briefly describe the common side effects of Pentobarbital and Thiopenthal, the symptoms in the anesthetic emergencies ; and how to diagnose and treat them.

SIDE EFFECTS OF PENTOBARBITAL AND PENTOTHAL

Following a single intravenous dose of Pentobarbital there is *early depression of blood pressure.* The heart rate decreases for 40 to 60 beats per minute (normal 100 to 130 beats/min.) and then stabilizes or increases. Respiration is initially depressed and gradually increases with time. Pentobarbital administration produces sudden depression of vital functions, like a shock showing abrupt decrease of respiration rate and depth, and decreased cardiac pulsation, and may actually terminate with death. This will vary with the size of the dose and method of its administration and also individual resistance to the drugs. However, Mylor et al (1943) explained that roughly one of every four animals given a dose of 30 mg/kg. develops side effects which may mimic some phases of experimental shock.

Thiopental Sodium (Pentothal), which was introduced as the first thiobarbiturate to gain popularity in its short anesthetic action for small animals, has however the

initial toxic effect producing a marked depression of respiratory centers, both rate and amplitude being affected. The pulse rate is slowed and blood pressure is depressed. Especially the respiration is strongly affected rather than the heart, and is much depressed when the additional injection of Pentothal is given. Pentothal solution should be stored in a refrigerator at 5 to 6°C (41 to 42°F) to retard deterioration.

Hypopnea may occur even in lightly anesthetized animals due to depression of the respiratory centers by the anesthetics.

Thiopental (Pentothal) commonly cause respiration to cease temporarily on induction. Apnea usually results from an overdose of anesthetic. Very shallow respirations and progressively developing cyanosis are the outward manifestation of this condition. In some animals, cyanosis develops followed by cardiac arrest.

Immediate care and treatments, such as artificial respiration through the tracheal canula or through endotracheal intubation in case that the tracheotomy and the insertion of the tracheal canula is not completed yet, should be taken since even mild hypoxia may eventually lead to respiratory or cardiac arrest.

Meanwhile, since narcotics depress the respiratory center, a specific antagonist, such as nalorphine or levallorphan, should be administered to those animals which have received preanesthetic narcotics.

In general, laryngeal and bronchial spasms usually occur in lightly anesthetized cats from stimulation of the respiratory tract; especially developing in cats given ether or one of the thiobarbiturates. The result is coughing accompanied by some degree of cyanosis. Intravenous meperidine in this situation will be effective for its spasmolytic action. By observing respiratory movements (costo-abdominal), the color of the tissues, pulsation of the blood vessels, and the color of the blood in the operation field, the operator and assistant continuously assess cardiac and respiratory function.

CARDIAC ARREST

Sudden cardiac arrest occurs sometime without any warning sign and is not infrequently overlooked. There is little indication of cardiac arrest such as sudden cease of bleeding in the operation wound, cyanosis, hypotension, changes in respiration, change of pupil, unexplained changes in the level of anesthesia and some change in the action potential as the C.R.O. observation is going on (same as changes in the EEG). Those will serve as a warning when we pay much attention to the animal condition.

Treatment of cardiac arrest and respiratory arrest:

Cardiac arrest is essentially a three-minute-emergency and this must be kept constantly in mind. Cardiac arrest can be successfully corrected, provided it is

recognized immediately and the appropriate procedures easily and quickly accomplished. Oxygenated blood must be pumped to the brain within three minutes after cardiac arrest occurs.

Closed cardiac massage:

The technique is to place the animal on its side and with a hand on either side of the chest, compress the chest over the heart 100 times a minute. A blood pressure of approximately 110/30 could be produced by this method.

Most of the attempts at cardiac rescusitation in small animals in the laboratory have been discouraging. But, sometimes the rescusitation has been successful.

Delay in diagnosis and in institution of rescusitation will invariably be fatal.

So, close and continuous observation of the animal condition through the experiments will be basic in manner and will produce satisfactory results.

SUMMARY

A technique for intravenous anesthesia with Pentobarbiturate (Nembutal) and Thiobarbiturate (Pentothal) and a procedure for tracheotomy in the cats in the daily experiments are described.

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