

## TERMINAL ARTERIAL ANÆSTHESIA.

BY J. LOUIS RANSOHOFF, M.D.,

OF CINCINNATI, OHIO.

SINCE the introduction of cocaine anæsthesia into surgery, there has been a constant tendency to its wider application, even to its use in the so-called major operations. With the exception of spinal anæsthesia, the methods of local anæsthesia now in use are not true anæsthesias, but rather analgesias. That is, the patient, while perceiving no pain, feels distinctly what is going on. This, in nervous patients, is of great moment, causing much discomfort and actual suffering.

What I hope to show is a method of perfect local anæsthesia applicable, it is true, only to a certain group of cases in limited areas of the body. The anæsthesia is induced by the injection of cocaine solution directly into the artery supplying the area to be anæsthetized. The following, printed in the *Lancet-Clinic*, is the original case report.

CASE I.—Male, aged 72. On service of Dr. Robert Carothers, through whose courtesy I am enabled to report this case. The patient had been suffering for three years from a chronic osteomyelitis of the hand, which became so painful as to necessitate an amputation. His age and condition contraindicated general anæsthesia.

Operation at Good Samaritan Hospital July 12, 1909. An Esmarch bandage was applied about the arm two inches below the insertion of the deltoid. Under infiltration anæsthesia, the brachial artery was exposed and the needle of a hypodermic syringe inserted into its lumen, and 1 c.c. of a 2 per cent. cocaine solution injected into the artery in the direction of the blood current. In two minutes anæsthesia was absolute and anti-brachial amputation done without the patient's knowledge.

There are two features of special interest in this case, the rapidity of anæsthesia and the fact that the operation was performed without the patient's knowledge. After the operation had been completed, the patient asked when we would begin. This absolute anæsthesia is a salient feature of this method as well as one of its greatest advantages.

CASE II.—Female, aged 50, service of Dr. Robert Carothers, Cincinnati Hospital. Diagnosis: Osteoma of scaphoid bone.

*Operation.*—Esmarch strap applied lightly above knee. Under

infiltration anæsthesia the anterior tibial artery was exposed just above the ankle, and 1 c.c. of 1 per cent. cocaine solution injected into the artery. This was immediately followed by complete anæsthesia of the entire foot, during which the osteoma was removed without the patient suffering the slightest pain. The further history was uneventful.

A series of animal experiments was now done to determine the certainty of anæsthesia, its safety and its applicability in operations other than amputations. In all, ten experiments were done. The first series in rabbits, the second in dogs. It will be seen that in operations other than amputations a 2 per cent. cocaine solution is too strong to be consistent with safety, because of the danger of absorption into the general circulation. A 0.5 per cent. cocaine solution was used and found in every way adequate.

In the experiments on rabbits, the femoral artery was selected as the site of injection. The artery was exposed in the upper part of Scarpa's triangle. One c.c. of 0.5 per cent. cocaine solution was injected into the artery in the course of the blood stream and tests for anæsthesia were immediately made. The experiment was in each case controlled by testing the sensibility of the other leg and distant parts of the body. The following uniform results were obtained: Irritation of the anæsthetized leg caused no response; that is, the animal gave no evidence of pain as, for instance, by drawing away the leg. Irritation of the opposite leg was invariably followed by all the evidences of pain.

Experiment 1. The bone was exposed as roughly as possible, the knife rubbed up and down the bone, stripping the periosteum. No pain.

Experiment 2. The femur was broken by manual force and the two ends of the bone rubbed roughly together.

Experiment 3. The foot was charred with a Bunsen flame. No evidence of pain.

Experiment 4. The femoral artery was torn, causing great hemorrhage and necessitating the abandonment of the experiment. This accident, very likely to occur in the thin walled artery of a rabbit, is impossible, as will be shown, in the thicker walled artery of a dog or man.

Experiment 5 and 6 were in all respects similar to the preceding experiments and need not be detailed.

The disadvantage of working on rabbits is manifest, the puncture of the thin walled artery was invariably followed by hemorrhage, necessitating the killing of the animal after the experiment. The perfection of the anæsthesia was determined, it is true, by the rabbits' experiments, but not its freedom from danger. Therefore, another series of experiments was done on dogs and the animals allowed to live.

Experiment 7. Large black-and-tan dog. Under ether anæsthesia, the femoral artery was exposed and 2 c.c. of 0.5 per cent. cocaine solution injected into the artery. The animal was now lifted from the dog board and allowed to recover from the anæsthesia. After fifteen minutes, the dog seemed perfectly normal, running about the room in the usual way. It was particularly noticed that there was an absence of any muscular paralysis. The animal was now tested for anæsthesia. The anæsthetized leg was pinched, scratched and slightly burned. No symptoms of pain were elicited. Irritation of the other leg and other parts of the body gave immediate response. After testing the anæsthesia for half an hour, the wound was united with a continuous suture. During this manœuvre, the most perfect demonstration of the anæsthesia was obtained. The point of injection into the artery lay about in the middle of the wound. The lower half of the wound was sutured without any evidence of pain, the animal lying perfectly quiet and seemingly unconcerned. As soon as the needle entered the skin above the point of injection the animal gave all evidences of severe pain, squealing and struggling. This demonstrated that the anæsthesia extends to the point of injection. The dog was watched for a week, during which no untoward symptoms were evidenced. The animal then escaped none the worse for his experience.

Experiment 8 was in every particular similar to the preceding experiment. The subject was a smaller animal and only one c.c. of 0.5 per cent. cocaine solution was used.

Experiment 9 is, according to present indications, more of scientific interest than of practical value. The dog was large. Under ether anæsthesia the common carotid artery was exposed and two c.c. of 0.5 per cent. cocaine solution injected into the artery. The wound was closed with a continuous suture and the animal allowed to recover from the anæsthesia. After about fifteen minutes recovery was complete and the animal was apparently normal. What was most interesting, was the complete absence of any deviation from normal intelligence. The animal ate and drank from a bowl, also gave every evidence of knowing what was going on about him. The animal was now tested for anæsthesia. The results were most gratifying. There was a complete anæsthesia of the entire head, face and upper part of the neck. The skull was exposed and a piece of bone chipped out. Deep incisions were made into the skin of the face, ears and neck. Even the very sensitive nose and lips were scarified without causing pain. Irritation of other parts of the body elicited symptoms of pain. The bilateral anæsthesia of the face and head may be explained by the very free anastomosis between the two carotid systems. A very interesting feature of this experiment is that sight was not interfered with, as shown by persistence of lid reflexes.

Experiment 10. Medium sized dog. Under ether anæsthesia the

femoral artery was exposed and 1 c.c. of 0.5 per cent. novococaine solution was injected. The experiment was a failure, the leg showing no diminution of sensation.

The nature of the anæsthesia is terminal,—that is, the cocaine is carried by the capillaries to the individual nerve endings. The solution is diffused through the capillary walls into the surrounding tissues, and very little, if any, is returned through the veins to the general circulation. This is shown by the purely local character of the anæsthesia.

The following technic is to be used in man. The main artery supplying the part to be anæsthetized is exposed under infiltration anæsthesia. An Esmarch strap is now bound about the limb some distance above the point of proposed injection into the artery. The Esmarch should be used as in the Bier hyperæmic treatment; that is, snug enough to constrict the veins, but not so tight as to interfere with the arterial circulation. From 4 to 8 c.c. of 0.5 per cent. cocaine in normal salt solution should be injected into the artery in the direction of the blood stream. The needle used should be as fine as possible. After anæsthesia is complete, the Esmarch may be tightened, if perfect hæmostasis is desired. At the end of the operation, the Esmarch is removed and the wound closed. The maximum dose suggested, that is, 8 c.c. of 0.5 per cent. cocaine solution—contains only 0.04 of cocaine, a safe dose. This method of anæsthesia is an ideal one for certain areas of the body where general anæsthesia is contraindicated. It is particularly applicable to the upper extremity, where the brachial, radial or ulnar artery may be exposed with little difficulty. For the larger operation on the lower extremity, where general anæsthesia is contraindicated, spinal anæsthesia seems more desirable, but for the operations about the foot and ankle this anæsthesia has a distinct place. The greatest advantage of this procedure is its safety, which depends on the small quantity of dilute cocaine solution used and its probable diffusion into the tissues.

Goyanes, 1909, describes a method of arterial anæsthesia similar to Bier's venous anæsthesia, in that large quantities of solution are introduced between the two tourniquets.