BLOOD SUPPLY CHANGES DURING CYCLOPROPAINE ANAESTHESIA

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EXCESSIVE bleeding during surgical operations can be caused by many factors other than the anaesthetic agent. The question first to be answered in an investigation into the reason why more than usual haemorrhage appears to accompany any one type of anaesthesia could be stated as follows: "Is bleeding increased only when the agent in question is being used?"

Cyclopropane, whose anaesthetic properties have more recently been discovered, is rapidly replacing its hydrocarbon predecessor, ethylene, as the agent most often accused of being responsible for increased bleeding during surgical procedures. The opinion that haemorrhage is excessive during operations under cyclopropane anaesthesia has been independently expressed by a number of surgeons and some anæsthetists situated in widely separated localities. It has been our experience that where the anaesthetic agent was unknown to the surgeon its identification merely by clinical estimation of the degree of bleeding during operation was usually not possible. While some observers simply state they witness more bleeding during cyclopropane anaesthesia,
others, including Griffith of Montreal, further qualify their criticism to include only capillary oozing. There appears to be general agreement that bleeding from the uterus in operative obstetrics, especially during Caesarean section, seems less than when other more commonly employed anaesthetics are used.

**Suggested Methods of Study.**

Observations have already been made regarding the bleeding and clotting time of the blood before, during, and following cyclo-propane anaesthesia, and no definite change was noted. It is, therefore, necessary that other experimental procedures be considered. An estimation of the total blood-loss during operation by complete recovery from sponges, packs, towels, instruments, etc., would afford a direct method. However, the difficulties and objections are numerous and because of individual differences in vascularity, an exceedingly large number of determinations would be necessary to arrive at any definite conclusion. We have on this account used more indirect methods of investigation, including a comparison of splanchnic and peripheral blood-pressure in dogs and a study of peripheral blood-supply changes in both animals and humans.

**Present Study.**

Although we have been concerned mainly with blood-supply changes during cyclopropane anaesthesia, for purposes of comparison, some observations have been made during the various depths of ether narcosis.

The method devised by Hanzlik, De Eds, and Terada to determine changes in the blood-flow in the ear of the rabbit by measuring changes in opacity with the aid of the photo-electric cell was so modified to make it suitable for studies on humans. The apparatus (Fig. 1) consists of (1) A source of light, namely a ro-watt lamp, the intensity of which is regulated by a non-flickering carbon rheostat. (2) A Weston photronic cell. (3) A Weston D.C. microammeter model 622.

The ear or some other translucent vascular area is interposed between the source of light and the photo-electric cell. An increase in the blood-supply of the area renders it more
opaque to the passage of light and thus reduces the current output of the photo-electric cell. Likewise a decrease in the amount of blood in the ear renders it more translucent, allowing more light to pass through, and results in an increase in current output of the cell. The terminals of the cell are connected to the galvanometer or microammeter which has a maximum needle deflection of 5 microamperes with 100 scale divisions, hence each scale division represents 0.05 microamperes.

The casing for the photo-electric cell is made of light sheet-metal and supports an adjustable hollow tube upright 2 centimetres in diameter and 10 centimetres high into the top of which is placed the lamp. The ear or other translucent skin area is inserted between the upper and lower segments of the tube. Light from a foreign source is prevented from entering by sponge rubber cushions which are attached to both the proximal and distal segments of the tube. These cushions, while they exclude light, are so adjusted that they will not constrict the blood-vessels. The possible error due to the heating of the light bulb was greatly reduced by making a series of observations instead of one continuous record. At the present time an attempt is being made to improve the apparatus by the addition of a suitable heat filter in order that a reliable continuous record might be obtained.

In humans, we have tried to correlate changes in depth of anaesthesia and fluctuations in blood-pressure with peripheral blood-supply changes as determined by differences in the current output of the photo-electric cell.

In dogs an oncometer was placed on the kidney to measure changes in its volume, a canula was inserted into the carotid artery for blood-pressure and the photo-electric cell was attached to the ear or the loose vascular flank of the female, which afforded a more satisfactory location if the ear was deeply pigmented.

**Technique of Administration of Cyclopropane.**

All the clinical cases were premedicated with a morphine-scopolamine combination or morphine and a barbiturate. The animals were all unpremedicated, and following induction of anaesthesia were rapidly intubated to insure against
changes due to respiratory obstruction. The carbon dioxide absorption technique with the “to and fro” canister of soda lime was employed from the time of induction of anesthesia and continued throughout in both humans and animals. Some of the patients were intubated and in others respiratory obstruction was guarded against by pharyngeal airways.

Studies Without Anesthesia.

We used the apparatus, described above, on ourselves to see if any change in current output of the photo-electric cell took place due to the heating effect of the lamp at the time the microammeter readings were made. No change was noted after 20 minutes when readings were taken at 2- and 5-minute intervals. An increase in the room temperature was noted to influence the peripheral blood-supply, causing a decrease in the cell current output before any feeling of increased warmth could be detected subjectively.

Moderate carbon dioxide excess (Fig. 2), such as occurs when oxygen is rebreathed for a short time, alters markedly the blood-supply to the ear. The blood-supply is increased as indicated by a diminished cell-current output, but sometimes this increase is preceded by a transient decrease in blood-supply and a consequent increase in the output of the photo-electric cell. The increased blood-supply resulting from an increase in tension of the inspired carbon dioxide is progressive in character and continues for some minutes after the mask is removed. Rebreathing was continued to the point of discomfort from carbon dioxide accumulation, but no additional carbon dioxide from a cylinder was used in any of the experiments. Following the diminished current output produced by carbon dioxide excess it was noted that the sudden application of cold to an extremity, such as was obtained by splashing ether suddenly on the forearm, quickly increased the current output of the cell. As a rule the changes in blood-supply were paralleled by changes in both the systolic and diastolic blood-pressure. During the recovery phase, however, the peripheral blood-supply changes lagged behind the return of the blood-pressure to its pre-experimental level.

As a result of the aforementioned findings it was con-
Cyclopropane Anaesthesia

Considered imperative to guard against any possible carbon dioxide accumulation or depletion during any stage of anaesthesia, cyclopropane and ether, each of which is capable of producing any depth of anaesthesia in the presence of an abundance of oxygen, were selected for comparison.

*Normal Reaction of the Photo-electric Cell to Changes in Cyclopropane Anaesthesia.*

During anaesthesia for extra-abdominal surgery, where the operative procedure is not attended with shock, the changes in the current output of the cell appear to bear a definite relationship to the depth of anaesthesia. In a typical case (Fig. 3) immediately anaesthesia is induced there occurs an increased cell output signifying an initial decrease in blood-supply. Simultaneously there usually occurs a slight rise in blood-pressure of say 10 mm. Hg. and there may be a further increase in blood-pressure, but nevertheless a reduction in cell current output. From this point on peripheral blood-supply changes bear more of a relationship to the depth of anaesthesia than to the change in blood-pressure. When anaesthesia is deepened there is a decrease in current output and an increase when it is lightened, indicative of an increase and decrease respectively in the blood-supply to the ear. The sensitiveness of the apparatus is remarkable and such slight differences in depth of anaesthesia as between the upper and lower borders of a single plane will cause variations in the current output of the cell independent of any change in blood-pressure.

*Impending Surgical Shock.*

In the presence of a constant plane of anaesthesia, we noted that an increased current output (Fig 4) preceded any change of blood-pressure, pulse-rate, or colour in a patient who five minutes later showed the characteristic progressive decline in blood-pressure and increase in pulse-rate which, if untreated, invariably leads to shock. After treatment was instituted the current output began to diminish. There was very little bleeding during the course of the operation.

*Hæmorrhage.*

The behaviour of the cell during operations, complicated
with sudden severe haemorrhage, is identical with the changes observed during impending shock from other causes.

Ether Anaesthesia.

Immediately anaesthesia is induced with ether there is a marked decrease in the cell current output which does not appreciably change with an increase or decrease in the depth of anaesthesia, although the blood-pressure changes may be considerable.

Experimental.

An effort was made to obtain a reading on the microammeter before anaesthesia, during induction, and during the various planes of the third stage of surgical anaesthesia in eight dogs. We found, however, that it was practically impossible to keep the cell in a fixed position during the struggling which attended the administration of the anaesthetic in the unpremedicated animal. Then too, the respiratory obstruction caused by marked salivation during induction would result in changes entirely unrelated to the anaesthetic agent. Therefore, when the blood-pressure manometer, kidney oncometer, and the photo-electric cell were functioning properly and anaesthesia was maintained at a constant level the kymographic record was started. Of particular note is the constancy of kidney volume during any one plane of anaesthesia with either cyclopropane or ether. When anaesthesia was deepened the changes in kidney volume were peculiar to each of the two agents. There was very little change when anaesthesia was deepened with cyclopropane (Fig 5), in fact a decrease in kidney-volume was observed to accompany a rise in systemic blood-pressure (Fig. 6) in some of the experiments. During ether anaesthesia (Figs. 7 and 8) the changes in kidney-volume paralleled the blood-pressure fluctuation attendant upon the particular plane of anaesthesia. The current output of the photo-electric cell varied with the depth of cyclopropane anaesthesia, decreasing with profound anaesthesia and increasing with recovery. In the course of ether anaesthesia there was very little change in cell output after surgical anaesthesia had once been attained.
FIG. 1

FIG. 2

INFLUENCE OF CARBON DIOXIDE EXCESS AND CARBON DIOXIDE DEPLETION ON BLOOD SUPPLY OF HUMAN EAR
3. CLINICAL CASE T. C. H. Operation - Thoracoplasty.

Fig. 3

Fig. 4
Fig. 7

Fig. 8
Cyclopropane Anaesthesia

These data would lead us to believe that there is a difference in the distribution of the blood during anaesthesia with cyclopropane and with ether. During cyclopropane anaesthesia the peripheral blood-supply appears to be influenced most and the splanchnic, insofar as can be ascertained by changes in kidney-volume, the least. In the course of ether anaesthesia the peripheral blood-supply changes are less remarkable while the splanchnic variations are quite distinctive.

Discussion.

Returning now to the question asked in the opening paragraph, "Is bleeding increased during cyclopropane anaesthesia?" it appears we do not have the answer by reason of this study alone. On the other hand, our findings might afford a reasonable explanation of why bleeding may appear to be greater during cyclopropane anaesthesia than during ether anaesthesia of comparable depth. The changes in peripheral blood-supply which occur within the upper and the lower limits of a single plane of cyclopropane anaesthesia suggest the retention of tonicity of the peripheral arterioles and capillaries. During ether anaesthesia there appears to be vasodilatation which changes very little with light or profound narcosis.

Conclusions.

1. The photo-electric cell affords an excellent qualitative method of studying blood-supply changes in humans as well as in animals.

2. Definite changes in blood-supply occur during ether and cyclopropane anaesthesia which are peculiar to each of the two agents.

References.
