REMARKS

ON

ONE OF THE CAUSES OF DEATH DURING THE
EXTRACTION OF TEETH UNDER
CHLOROFORM.

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IN a clinical lecture delivered by the late Professor Syme, several years ago, he made the somewhat remarkable statement that, notwithstanding his constant use of chloroform for many years, he had never had a death from it occur in his practice. The reasons he gave for this success were two. "First," said he, "we always use good chloroform; and, second, we always give plenty of it." Now, others besides Professor Syme have used good chloroform—have used, indeed, chloroform by the same makers, and altogether undistinguishable from that employed by him; and yet they have had to deplore the occurrence of deaths during its administration. This fact of itself is sufficient to show that the second reason given by Professor Syme for his success is of great importance; and that, in administering chloroform, it is just as necessary to give plenty of it as to use only the best quality. It is, indeed, very extraordinary to see how timidity in the use of chloroform seems to be associated with a more than ordinary fatality; and how the careless—one would say almost reckless—employment of it is frequently unattended with any inconvenience. In Snow's work on *Chloroform*, p. 151, the following passage occurs. "In Guy's Hospital and St. Thomas's, the medical officers had a strong objection to narcotism by inhalation for the first two or three years after the practice was introduced, and chloroform was used much less generally in these institutions than in any other of the hospitals of London; yet it was precisely in these two hospitals that two deaths from chloroform occurred before any such accident had happened in any other hospital in this metropolis." Dr. Snow seems inclined to attribute both of these deaths to the administration of chloroform; but a careful consideration of them may lead us to another conclusion. Before attempting to analyse these cases, however, I wish to recall to the memory of some here an anecdote regarding the introduction of chloroform into the Edinburgh Infirmary, which Mr. Syme was accustomed to relate in his clinical course. One of the surgeons of the Infirmary, I believe the late Professor Miller, had agreed to Sir James Simpson's request to perform, for the first time, an operation under chloroform. Everything had been prepared, and the tray containing the instruments and bottle of chloroform was being conveyed into the operating theatre, when the bearer stumbled and fell, and the whole contents of the bottle were irretrievably lost. There was no time to get more chloroform, and the operation was performed without it. The patient died on the table. Had chloroform been administered, the death would have been put down to the anæsthetic, and not to the operation; and, in all probability, not another drop would ever have been used.

This case shows us—and it is only one of many—that deaths used to occur from shock during operations before the introduction of chloroform, but they were then put down to their true cause; whereas, since its introduction, one hears little or nothing of death from shock, and much of death from chloroform. Another circumstance which is well worthy of notice, and which ought to be borne in mind, is the frequency with which the remark occurs in the descriptions of these so-called deaths from chloroform, that a fatal result was all the more extraordinary and unexpected because the quantity of chloroform administered had been exceedingly small. Mr. Syme would have said that, instead of being extraordinary, it was the very thing to expect; and if, like him, the operators had given plenty of chloroform, their patients would not have died.

And now let us look at the first two cases of death *under chloroform*—I will not say *from chloroform*—in these two London hospitals, where such a dislike to the anæsthetic was felt.

John Shorter, aged 48, a porter, known to Mr. Solly for some time as a very active messenger, of intemperate habits, but apparently in perfect health, was admitted into George's Ward, under Mr. Solly, on the 9th October, 1849, suffering from onychia of the left great toe, which had existed some time. It was determined to remove the nail, the man having decided, before entering the hospital, on taking chloroform.

On Wednesday, October 10th, at a quarter before 2 P.M., he began to inhale the chloroform, with one drachm in the inhaler. It had no visible effect for about two minutes; it then excited him, and the instrument was removed from the mouth, and about ten drops more were added; he then almost immediately became insensible; the chloroform was taken away, and the nail removed. He continued insensible; and, his face becoming dark, the pulse small, quick, but regular, respiration laborious, his neckerchief was removed, and the chest exposed to fresh air from a window near to the bed; cold water was dashed in his face, the chest rubbed, and ammonia applied to his nose. After struggling for about a minute, he became still, the skin cold, pulse scarcely perceptible, and soon ceased to be felt at the wrist; respiration became slow at intervals, but continued a few seconds after the cessation of the pulse.

The subject of the second case was Alexander Scott, aged 34, a police constable, who died in Guy's Hospital in June 1850, whilst undergoing an operation for the removal of a portion of the right hand. Mr. Cock, the operator, said that he was certain there was no disease about the patient. He described the accident as follows. The ordinary machine was used; and, as it had not the effect, witness directed that a napkin should be folded into the shape of a cone, which was applied with chloroform. The removal of a portion of the bone occupied one minute and a half; but, before it was completed, the blood, which was gushing out, suddenly stopped, when witness directed Mr. Lacy to feel the pulse of the deceased, and they found that the deceased had expired.

The sudden stoppage of the hæmorrhage shows that, in this case, as in others, the action of the heart was suddenly arrested. The first attempt to cause insensibility failed in this as in some other cases.

Let us take yet another case, the second one ever recorded of death under chloroform. The patient, a healthy woman, thirty-five years of age, was taking chloroform in order to have several teeth extracted. The following account of what occurred was given by two female friends of hers who were present at the operation. "The respiratory movements appeared to be free; chest heaving. Whilst inhaling, the face became pale. At the expiration of about one minute, the instruments were applied, and four roots of teeth were extracted. The patient groaned, and manifested what they regarded as evidences of pain, while the teeth were being extracted, although she did not speak, or exhibit any other sign of consciousness. As the last root came out, which was about two minutes from the beginning of the inhalation, the patient's head turned to one side, the arms became slightly rigid, and the body drawn somewhat backwards, with a tendency to slide out of the operating chair. At this instant, Mrs. Pearson states, she placed her finger upon the patient's pulse, observed it was feeble, and immediately ceased to beat. The face, which was previously pale, now became livid, as did also the finger-nails; and the lower jaw dropped, and the tongue projected a little at one corner of the mouth, and the arms were perfectly relaxed. The females regarded her as being then quite dead."

In two of these cases, death occurred after the inhalation of chloroform had been discontinued; and in the third, the chloroform seemed to have no bad effects until the operation was begun. In all of them, the death followed the operation, and must, I think, be attributed to the shock caused by it. But what is shock? and is there more than one kind of it? for the symptoms were not the same in all these cases. In two of them, the heart seemed to stop suddenly; while, in the third, it failed gradually, although it ceased before the movements of breathing; and the death must therefore be attributed rather to arrest of the circulation than of the respiration. The circulation is kept up in the body by the heart constantly pumping the blood out of the veins into the arteries. Whenever the heart stops pumping, or whenever it gets no blood to pump, the circulation will stop. It does not matter how much blood is in the vena cava or right auricle waiting to be sent into the arteries, if the heart be not beating; nor is the case a whit better when a wound in the jugular has drained away all the blood, so that no efforts of the heart, however numerous and however vigorous, can send a drop of blood into the aorta.

It must be recollected that blood is only useful to the tissues when it is in the arteries, just as water is only available for household purposes while it is in the cistern or supply-pipes. Once the water gets into the sewer, it is of no more use, unless it can be filtered and again pumped back into the cistern; and once the blood has got into the veins, it is no more use unless it can be purified by the lungs and pumped back into the aorta, from which it may once again pass to nourish the tissues. The only difference between blood still in the veins and blood which has run out of them into a basin, is that, when in the basin, it cannot get to the heart, and be pumped by it into the arteries; while, so long as it is in the veins, it generally reaches the heart readily. But

Although it generally does reach the heart easily, it does not always do so. Sometimes it accumulates in the veins of the abdomen, and never reaches the auricle; so that it might just as well be in a basin or any use it is to the heart or body. This was shown by Professor Goltz of Strasburg by a remarkable experiment. After exposing the heart of a frog, he noticed that it beat regularly, and at each beat sent a quantity of blood into the aorta, again becoming full of blood in the interval between the pulsations. The frog's heart is partially transparent; so that it is easy to see by its colour when it is empty and when it contains blood. He now struck the frog's intestines pretty hard, and found that the heart stopped. The irritation produced by the blow had been conducted up to the medulla oblongata; and, being reflected down the vagus nerves to the heart, had stopped it. After a little while, the heart seemed to recover, and began to pulsate again. But there was a very remarkable difference between its appearance now and its appearance before the blow had been given. Instead of becoming filled with blood during each diastole, and assuming a deep red colour in consequence, it remained quite pale and empty; and, although it contracted vigorously, the circulation stopped, for the heart had no blood to propel. On looking at the vena cava, Goltz found the cause of this phenomenon. The frog was hanging with its legs downwards, and the vena cava was not full up to the level of the heart. Usually the vena cava and veins of the intestines are kept in a state of semicontraction or tone by the vaso-motor nerves, but now they had become completely relaxed; so that the blood which usually would have filled them completely up to the heart was not sufficient, and so they were only about half full. On laying the frog in a horizontal position, the blood ran towards the heart. It was thus evident that the blow on the intestines had done something more than stop the heart. It had also stopped the usual action of the vaso-motor centre; so that the veins, instead of remaining in a state of tonic contraction, became widely dilated. And, be it noticed, this dilatation of the veins in Goltz's experiments was more permanent than the stoppage of the heart, and continued after the cardiac pulsations had recommenced. But all frogs are not alike; for sometimes a blow on the intestines will stop the heart without having much effect on the veins; and sometimes it will cause the veins to dilate, and will not stop the heart, although very often, as I have already said, it will do both. The same effects seem to follow blows on the abdomen in man and in the frog, but with this difference: in the frog, the heart may stop for some time, and again go on without much injury to the animal; in man, the stoppage of the heart produces death in not many seconds. A good example of this is to be found in Sir Astley Cooper's *Lectures on Surgery*; where he relates that a healthy labourer belonging to the India House was attempting to lift a heavy weight, when another labourer came up and said, "Stand on one side; let an abler man try". At the same time, he gave the former a slight blow on the region of the stomach, when the poor fellow immediately dropped down and expired. On examination of his body, there was not any mark of violence discovered. Here, no doubt, the blow in the abdomen stopped the man's heart, just as it does in the frog; and death occurred before the organ had time to recover from the shock. In another case, described by Professor Fischer, a young man was struck in the abdomen by a carriage-pole; and, after the accident, lay pale and motionless, with a feeble pulse, empty arteries, deep sighing respirations, and a livid tinge on his hands and lips. In this instance, the heart had either not been stopped at all, or had speedily recovered itself; but the abdominal veins had been so dilated that all the blood in the body could hardly fill them sufficiently to leave a dribble over for the general circulation, although a little still did trickle into the heart so long as the patient remained in the recumbent posture.

We have, then, two forms of shock, according as the injury produces its effect chiefly in the heart or chiefly in the vessels. But it is not merely blows on the abdomen which have the power of producing shock; irritation of other parts can do so likewise; and this seems to be peculiarly the case with regard to bones. Thus Pirogoff records two cases in which death occurred during operations before the introduction of chloroform. In both, the pain and loss of blood during the operation was only a little greater than usual; yet in both, immediately after the bone had been sawn through, the face became pale, the eyes staring, the pupils dilated, a peculiar rigidity of the body occurred, and death immediately took place.

The symptoms in these cases of Pirogoff's are almost exactly the same as those of Mr. Cock's case I have already described; but Pirogoff's deaths were put down to the operation, because no chloroform had been given; while the death in Cock's case was ascribed to the anæsthetic, because some chloroform had been administered; although, on account of the operator's unwillingness to give it at all, the quantity was probably very small.

In all three, it is evident that the heart stopped suddenly; and this in itself was sufficient to cause death, though it is highly probable that dilatation of the abdominal vessels also occurred.

In Mr. Solly's case, the dilatation of the abdominal vessels seems to have been the chief cause of death; for the pulse became gradually, though rapidly, weaker and weaker, and then stopped altogether, just as we would expect it to do if the heart suddenly ceased to be supplied with blood.

In the third case I have described, probably the heart was chiefly affected; for, just as the fourth stump of a tooth was removed, the pulse was felt to be exceedingly weak, and almost immediately afterwards became imperceptible.

Stoppage of the heart's action, then, being of such importance as a cause of death, we must now inquire how it is produced. The heart is kept pulsating rhythmically by the motor ganglia which it contains within itself, and will continue to pulsate for some time after its complete removal from the body. But though it thus shows its power to contract independently of the central nervous system, it is, nevertheless, influenced to a great extent by the nerve-centres within the cranium. It would never do to have the heart acting without reference to the wants of the system, and pumping blood vigorously into the arteries when the pressure within them was already too great, or acting slowly and feebly when the limbs were engaged in severe work, and wanted an abundant supply of blood to enable them to perform it. There are, therefore, nerves, some accelerating and others retarding the heart, which pass to it from the medulla oblongata, and, acting as the spur and reins of a rider do upon his horse, regulate its beats in accordance with the wants of the system. The retarding fibres are contained in the vagus nerve; and, when this nerve is irritated strongly, the heart will either stop immediately in diastole, or will beat very slowly and more feebly. Nor is it only by direct irritation of the vagus that this result can be attained. Just as irritation of a sensory nerve sets motor nerves in action, and produces various muscular movements by reflex action through the spinal cord, so may irritation of a sensory nerve set the vagus in action and produce stoppage of the heart, by acting reflexly through the medulla oblongata. A good many sensory nerves can do this; but there is one which possesses the power in an especial degree. The roots of the fifth nerve are anatomically closely connected with those of the vagus; reflex stoppage of the heart is produced more readily by irritation of the fifth than of any other nerve. In many rabbits, the heart can be instantaneously stopped by irritating the nasal branches of this nerve by a pungent vapour, such as ammonia, held before the nose. In every rabbit, or almost every rabbit, indeed, we can stop the heart by a pungent vapour applied to the nose; but we do not always do it in the reflex manner I have just described. The animal always closes its nostrils to prevent the entrance of the vapour, and keeps them closed so long, that the carbonic acid accumulating in the blood begins to act on the vagus and stop the heart. But this only occurs after the vapour has been held before the nose for some time; while the reflex stoppage which I have just mentioned takes place at once, almost simultaneously with the closure of the nostrils. This reflex stoppage has been shown by Hering and Kratschmer to be due to the irritation being conveyed along the nasal branches of the fifth nerve to the medulla, whence it is reflected along the vagus to the heart, and stops it.

Yet, notwithstanding the stoppage of the heart, the rabbit does not die; nor is it, indeed, any the worse. Why is this? Usually, when the heart is stopped, as, for example, when a ligature is put round the aorta, the blood all runs out of the arteries into the veins; and then, as I have said, it is useless for nutrition. But there is a nervous arrangement which prevents this when the heart stops, in consequence of an irritation applied to the fifth nerve. This nerve not only contains branches which are connected with the vagus and stop the heart or retard it; but it also has branches which go to the cerebral hemispheres, and there excite an action which passes down the vaso-motor nerves, causing the auricles to contract, and preventing the blood from running out of the arteries into the veins, except very slowly indeed; so that, as soon as the irritation stops, the circulation is ready to go on normally. But it is only when the cerebral hemispheres are in good working order that this occurs. When they are removed, or when their function is destroyed by chloroform, morphia, or chloral, irritation of a sensory nerve, such as the fifth, no longer has the same effect; and it then always, according to Cyon, lessens the pressure of blood in the arteries. As it is, the pressure of blood within the arteries which keeps up the flow within them, just as it is the pressure of water within the pipes supplying a town which keeps up the supply to the houses, we can readily see that the diminished pressure which occurs on the irritation of a sensory nerve after the cerebral hemispheres have been rendered useless by a small quantity of chloroform is a most serious

thing for the animal. But here it is a little chloroform which is a dangerous thing; and a full dose prevents any risk from this reflex stoppage of the heart. For the small dose acts on the cerebral hemispheres first, and destroys the reflex action, which contracts the vessels, while it leaves the ganglia at the base of the brain and the medulla unaffected, and thus allows the reflex stoppage of the heart to go on as usual. A full dose, on the other hand, affects not only the cerebral hemispheres, but the ganglia and medulla, and prevents any reflex action whatever on the heart. I have found that, when a full dose of chloroform has been given to a rabbit, one may hold either strong ammonia or glacial acetic acid before the nose, and not the slightest slowness in the beats of the heart can be observed. Sometimes, indeed, it has seemed to beat rather more quickly than before.

Now let us try to apply these observations on the lower animals; and, by them, try to explain the action of chloroform on man, and the danger of employing it in the extraction of teeth, as well as in other slight but painful operations. For it is precisely in these slight but painful operations—extraction of teeth and evulsion of nails—that death most frequently occurs; and it is just in them that little chloroform is given, because the administrator thinks: "Oh, the operation won't last above a few seconds; and it is no use giving the patient enough to keep him or her snoring for half an hour." We know perfectly well that many and many an one has teeth drawn under chloroform without any bad result; and we have already seen that every rabbit has not the same liability to reflex stoppage of the heart from irritation of its fifth nerve; but every now and then we meet with a peculiarly sensitive animal, and every now and again we meet with a case of death from the extraction of a tooth under chloroform.

If the nervous system in man be at all like that of the rabbit, the violent irritation of the fifth nerve caused by the extraction of a tooth will tend to stop the heart. But it will also cause contraction of the blood-vessels; and thus extraction of a tooth in the waking state is rarely attended with any serious consequences. But if the reflex action on the blood-vessels, which usually occurs in the cerebral hemispheres, be prevented by a small dose of chloroform, just enough, as in the case I have related, to abolish consciousness without preventing reflex action in the ganglia at the base of the brain, and if the heart of the individual be at the same time peculiarly sensitive to the impression made on the fifth nerve, it may be stopped, and the pressure of blood in the arteries may sink so low that it never rises again. But if, on the other hand, chloroform be given, as Professor Syme recommended, with a free hand, so as to produce total abolition of reflex action, no irritation of the fifth nerve by the extraction of any number of teeth will have any effect; the heart will pulsate as usual; and no danger is to be apprehended from this cause.

I do not at all mean to say that the administration of concentrated chloroform vapour is free from danger—far from it; but the limits of my paper will not allow me to enter into this subject. All I can attempt to do is to direct attention to the observation of Professor Syme, whose acuteness and accuracy few will question; and to try to impress it, by showing the probable physiological reason why one ought always to induce perfect anaesthesia before beginning any operation under chloroform. At the same time, I would observe that, just as the circulation, which had ceased in the frog in Goltz's experiment so long as it hung vertically, went on again when the animal was laid in a horizontal position so that the blood found its way to the heart, so it may go on in man; and, therefore, the safest position for operations is the recumbent one.

The two rules, then, for preventing death during the extraction of teeth under chloroform are: put the patient thoroughly over, and lay him in a horizontal position.

CONGENITAL DISLOCATION OF THE KNEE-JOINT.—Drs. Porter and Richardson report (*Boston Medical and Surgical Journal*, September 16th) two cases in which the knee-joint was dislocated at birth, the displacement having occurred *in utero*, as was evident from the furrows above and below the joint, and the deposition of vernix caseosa in the angle of flexion. In one case, the leg was in a vertical position, the inner malleolus facing towards the umbilicus, and the foot strongly rotated outwards. In the other, the leg was in such an extreme state of tension as to amount to reversed flexion, being turned upward and forward on the thigh, so that the anterior surfaces of the leg and thigh touched each other, the sole of the foot looking directly towards the face of the child, the toes pointing backward, the heel forward. By gentle firm traction, the dislocation was in each case reduced; and the use of a splint in the more severe instance, and of a simple bandage in the other, sufficed to keep the bones *in situ*, and resulted in perfect cures.

ABSTRACT OF CLINICAL LECTURE

ON

PUNCTURE OF THE BLADDER *PER RECTUM*.

Delivered at the Westminster Hospital.

By RICHARD DAVY, F.R.C.S.,

Surgeon and Lecturer on Anatomy at the Hospital.

GENTLEMEN,—This operation is a most valuable one for cases of retention of urine, where any physical obstruction prevents the introduction of a catheter into the bladder, after fair trial on the part of a competent surgeon. It was originally introduced into practice by Mr. Cock, consulting surgeon to Guy's Hospital; and his wide experience coincides with my own comparatively limited observation, that there is scarcely any surgical operation so devoid of danger as puncture *per rectum*. The necessary detail of the old operation is now demonstrated to you on this dead body; and the instruments are the same as generally used; viz., a solid trocar and cylindrical cannula, the latter being retained in the bladder by tapes.

In 1870, being impressed with the disadvantages of retaining for any length of time an unyielding tube *per rectum et vesicam*, I introduced the instrument (Fig. 1), in which the steel slotted cylinder is outside,

Fig. 1.

and acts as a perforator, carrying the elastic catheter as an inside passenger. Fig. 2 shows the catheter withdrawn, also the reduplication of the tip of the catheter, by means of which it is retained in the bladder. The patient is placed after the operation on a mattress having a circular hole corresponding to the buttocks; the end of the catheter falls through this hole, and conducts the urine into a receiving vessel on the floor below. Faeces also are thus passed without moving the patient.

Fig. 2.

I have yet further applied this principle of giving the urethra rest to those cases of obstinate perineal fistulae that are *not dependent* upon an obstructed urethra for their persistence. I am of opinion that a simple operation like puncture *per rectum* is more effectual and easy than periodic introductions of a catheter; the object being in both cases to avert the irritating urine from the damaged urethra and fistulae, especially so because in some cases men have not the power of retaining their urine; and it is impossible by the most skillful catheterisation to avoid some disturbance to the urethra, and some extravasation of urine over the exposed surface of it and the fistulae.

I have been in the habit of comparing the *rationale* of puncture *per rectum* in fistulous cases to the method pursued by workmen when repairing the damaged banks of a running stream. Their first object is to completely divert the stream from the seat of their repairs, so that one day's wash shall not outweigh one day's work; and this argument applies with double pathological force to the irritating urine as compared with the pure water. But a moment's reflection makes a surgeon see how inapplicable Cock's method would be for opening an empty bladder; and, at the risk of the charge of superfluity, I venture to bring you acquainted with a new instrument, and a new method of operating on this much operated on human perineum. The instrument consists of a staff, on which slides a silver cylinder, and a remov-