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SOME CASES OF CEREBRAL DISEASE IN WHICH THE FUNCTION OF RESPIRATION ENTIRELY CEASES FOR SOME HOURS BEFORE THAT OF THE CIRCULATION.

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SOME CASES OF CEREBRAL DISEASE IN WHICH THE FUNCTION OF RESPIRATION ENTIRELY CEASES FOR SOME HOURS BEFORE THAT OF THE CIRCULATION.[1]

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The cases which I proceed to relate illustrate a remarkable point to which attention has not hitherto been much directed in clinical study, namely, the persistence of life for some hours in the absence of all respiratory effort. Such cases cannot be of frequent occurrence, or they would certainly have been more fully recognised in the present day, when attention is so carefully directed to the minutest clinical details. As I shall point out, however, several surgeons have observed the facts of which I now give details.

I append the notes of four cases in which the respiratory function ceased for varying periods of time before death.

Case 1.—M. E., female, æt. 15—under the care of Mr. Butlin—5th June 1896.

History—Present condition.—27th May.—Vomited; headache.

1st June.—To bed; been sick two or three times daily, not immediately in relation to food. Headache always referred to back of head; no shivering; constipated; no fits.

Previous history.—Measles, five years ago; otorrhœa (left) for one year.

Present condition.—Not unconscious, dull, much pain in head, but no retraction—chiefly occipital pain in paroxysms. Eyes.—Pupils equal; react; no squint; early optic neuritis, both eyes. Pulse, 60; respiration, 20; heart and lungs natural. Urine, 1028; albumin. Abdomen retracted; no fever. Temperature, 99°. Knee-jerk present. Very offensive discharge from left ear; membrane gone, granulations seen growing from middle ear; no tenderness over mastoid region.

6th June.—Temperature subnormal; pulse, 58; has vomited several times—green and watery matters with some mucus.

[1] Read (in French) in the Section of Medicine, International Medical Congress, Moscow, August 1897.

7th June.—More drowsy; operated on by Mr. Lockwood.

6 P.M.—Trephined 1 in. above left ear, at a point in a vertical line with the meatus.

Patient's condition did not allow of exploration of cerebellum; trocar put into brain substance, no matter escaped. Respiration failed. Artificial respiration until 9.45 P.M., when heart stopped also.

Temperature on admission, 99°, afterwards 98°; pulse almost constant, 60; respirations, 22–24.

Post-mortem examination.—External anterior meatus and middle ear full of blood and granulations; middle ear much eroded, and communicating directly by an opening in its posterior wall with an abscess in the cerebellum. Roof of tympanum very thin, but not actually perforated; some pus in petrous bone, with slight localised meningitis around it, none anywhere else. Cerebrum quite natural. Cerebellum.—At anterior and outer part of left cerebellar hemisphere an abscess, 1¼ in. wide antero-posteriorly and 1½ in. transversely. Left side of pons and left superior peduncle flattened; very little brain substance separated the abscess from the fourth ventricle. Pus of dirty green colour, and viscid—not offensive. No disease found in any other part of the body.

CASE 2.—M. F., female, æt. 21; a box-maker; admitted 7th October 1896, under Sir Dyce Duckworth's care. Quite well till fourteen days ago. Then sore throat and severe frontal headache—occasional at first but afterwards continuous. Screamed out at night.

1st October.—Vomited several times. For past week or ten days pain in right ear. Often had discharge from ear, but not constantly with pain, and has been slightly deaf with right ear for past two months. Increasingly drowsy looking since onset, and heavy. For one week been in bed, delirious, and has sweated much. Bowels confined; no urinary difficulty; no ocular symptoms.

Previous illnesses.—None of importance; winter cough; no hæmoptysis. On 21st September fell on pavement, did not hurt her head.

Family history.—Father died of "consumption"; nothing else of importance.

Present condition.—Well-nourished, sleepy looking, continual frontal pain, increased by pressure, and slight pain on pressing right external auditory meatus; none over the mastoid process. Slight discharge from the right ear. Eyelids drooped. Eyes.—Pupils equal, react to light and accommodation; no squint, no nystagmus. Fundus.—Natural veins readily seen pulsating. Pulse, 48; regular; moderate tension. Heart.—Nothing abnormal to note, either in position of apex or area of cardiac dulness. Reduplication of first sound at apex. Lungs.—Nothing abnormal discovered. Abdomen.—Not retracted, no viscus felt. Legs.—Knee-jerk obtained; no ankle-clonus; no paresis noticed anywhere, except drooping of eyelids; sensation not impaired. *Tache cérébrale* readily obtained. Temperature on admission, 100°·4. Urine.—Sp. gr., 1020; acid; albumin, 0; sugar, 0. Bowels.—Confined.

11th October.—General condition not so good; still much pain, only temporarily relieved by phenacetin. Increased pallor, slight flattening of left side of face. Pulse.—Dicrotic and of lower tension, still infre-

quent, irregular. Respirations.—Occasionally sighing. Quite conscious. Temperature fallen since admission, now 98° to 99°.

12*th October.*—Very restless night; no sleep till 5.30 A.M.

11 A.M.—Sleeping deeply; breathing regular, 22 to minute. Pulse, 68; more irregular. Pupils, right larger than left.

11.15 A.M.—Snoring loudly.

12.15 P.M.—Breathing stopped; patient growing blue; artificial respiration begun; patient made a few attempts to breathe. Slight double external squint; pupils insensitive to light; no corneal reflex. Temperature, 98°·8.

1.45 P.M.—Condition unaltered; artificial respiration continued.

2 P.M.—Oxygen gas was given.

3.30 P.M.—Condition still unchanged.

3.45 P.M.—Trephined by Mr. Langton behind right mastoid process; exploring needle inserted in various directions, and finally a little pus obtained. Cannula inserted, but no more pus withdrawn. During the operation, artificial respiration being stopped, the patient grew increasingly blue, and pulse could not be felt at the wrist; but with renewal of artificial respiration and oxygen, and injection of liquor strychninæ, the patient got a good colour, and the pulse at the wrist became of good volume.

5 P.M.—Pulse gradually failed, and patient died. On examining the eyes immediately after death, there was no definite optic neuritis. Respiration ceased 12.15, and heart ceased to beat four and three-quarter hours later.

Treatment.—Phenacetin was used for the relief of pain in the head; 2 drms. were given between 6.30 P.M. on the 10th, and 5 A.M. on the 12th. During the last five hours of life liquor strychninæ was used freely hypodermically.

Post-mortem.—No sign of meningitis except just at roof of right tympanic cavity. Dura mater grey and sloughy, and an opening connecting middle ear with an abscess in right temporo-sphenoidal lobe. No increase of cerebro-spinal fluid. Right temporo-sphenoidal lobe swollen; convolutions much flattened; contained an abscess the size of a hen's egg. Much sclerosis of the right petrous bone, which contained a little caseous pus. No necrosis. No other lesion of importance found in any other part of the body.

Case 3.—W. C., æt. 36; carpenter; admitted to Rahere Ward under Dr. Brunton, 6th May 1897, and transferred to Charity Ward under Mr. Butlin, on 9th May. He came in complaining of headache and vomiting.

History.—Present condition.—For the last five months has been losing flesh. Fourteen days ago headache began, and got worse till 1st May, when he went to bed.

2*nd May.*—Was very hot and had profuse sweating.

5*th May.*—Diarrhœa (three times a day). Vomited four times before admission; the vomiting now only occurs after taking medicine. He has been delirious since the 3rd May; before that date he had complained of pain in the lower part of his back.

Previous history.—Enteric fever fourteen years ago.

Family history.—None of importance.

Present condition.—Patient is very restless; he lies on his back with his legs drawn up, and tries to get his feet out of bed. He appears to be semiconscious, and objects to being disturbed. Has hiccough. Keeps his head turned to the right, and objects to having it rotated to the left. Temperature, 100°·6. Face.—Skin slightly moist; left side smoother than right; no apparent paralysis; numerous minute dilated venules on the cheeks. Eyes.—Orbicularis acts strongly on both sides; some mucoid discharge from the left eye. Pupils equal, react to light, not dilated nor contracted. *Per* ophthalmoscope.—Both discs swollen; the apparent outer edges blurred. Veins distended and tortuous; arteries small; outer edges of disc very white. *Tache cérébrale* is easily obtainable. Tongue.—Dry and furred; sordes on lips and teeth. Chest.—Natural; a systolic murmur heard at the apex. Abdomen.—No distension nor retraction. Legs.—No rigidity; no paralysis; knee-jerks natural. He passes his urine under him.

7th May.—Not been sick; much quieter; hiccoughed twice. He is quite sensible, and complains of pain in the frontal region; has passed his urine naturally. He has an offensive discharge from his right ear. There is no swelling nor tenderness over mastoid process. A perforation is seen in the upper part of the drum.

8th May.—Slept quietly; still irritable.

9th May.—Much more drowsy; breathing stertorous; corneal reflexes almost gone; pupils are unequal, the right being larger than the left. Coma increased at about 12 noon, when respiration ceased, and artificial respiration was resorted to. Liquor strychninæ (5 minims) was injected subcutaneously, and repeated at 1 P.M. Oxygen was given as required. There was some temporary improvement, and patient was taken to the theatre after Mr. Butlin had seen him for the first time. Patient was anæsthetised and given liquor strychninæ (13 minims); artificial respiration was meanwhile kept up by rhythmical pressure on the sternum. The respiration centre appeared to be inhibited, and the chest was consequently in a state of over-inspiration. Mr. Butlin operated, and made a horizontal incision about 4 in. long, and a little below the level of the pinna, with a slight convexity downwards. The bone being laid bare, a small trephine was applied 1 in. above Reid's base line, and 1¼ in. behind the level of the external meatus. When the bone was removed the dura mater bulged into the cavity; it was of a purplish colour, and did not pulsate. Mr. Butlin made a small puncture in it, and, having passed a good-sized director about 3 in. forwards and inwards, pus at once flowed out freely, mixed with a good deal of blood. A medium-sized drainage tube was put in, entering well into the abscess. During the operation, as soon as the intracranial pressure was relieved, the breathing became normal, and artificial respiration was stopped.

On returning to the ward, the patient remained comatose. Respiration, 32; pulse, 132, full and bounding, but of low tension. Pupils dilated, but did not react to light. There appeared to be some slight palsy on the left side of the face. Patient was lying slightly on the left side, and the cheek became puffed out at each expiration. The jaw had to be continually pressed forwards to insure breathing. The patient

did not recover consciousness, and died at 6 P.M. (about two hours after the operation).

Post-mortem notes.—External appearance.—A fairly muscular man. Behind the right ear a recent operation wound with drainage tube and stitches *in situ*. Head.—A trephine hole on right side, $\frac{3}{4}$ in. (18 mm.) in diameter, the centre being situated exactly $1\frac{1}{2}$ in. (36 mm.) above and the same distance behind the external auditory meatus. The dura mater below this had a small wound in it, in which the drainage tube lay. There was no pus outside the dura mater nor anywhere outside the brain, nor were there adhesions between the membranes and the brain except at the outer and the back part of the upper surface of the right petrous bone, where a small tract led directly from the right middle ear to a large abscess in the right temporo-sphenoidal lobe. The temporo-sphenoidal convolutions were much flattened. The abscess was evidently rather old, as it had very well-marked pyogenic membrane. It measured exactly 2 in. in the antero-posterior diameter. Its centre lay exactly above the centre of the external auditory meatus. Its anterior border was $\frac{4}{5}$ in. from the point of the temporo-sphenoidal lobe. The posterior edge did not reach quite so far back as the trephine hole, about $\frac{1}{8}$ in. short of it. Superficially, it was covered by a thick layer of brain, about $\frac{2}{5}$ in.; but on its deeper surface not more than $\frac{1}{8}$ in. separated it from the lateral ventricle. No actual communication with the lateral ventricle could be found. The drainage tube lay in the abscess cavity, which had been opened from behind. The ventricles of the brain contained blood-stained serum, but no pus. There was a good deal of blood and turbid serum at the base of the brain in the posterior fossa. In the pons several small hæmorrhagic streaks; they were quite recent, and appeared to be the result of intra-cranial pressure. The cerebellum and other parts of the brain were normal. The petrous bone on the right side was the seat of old caries and full of pus. The left one was normal. The abdomen and its viscera were quite natural.

CASE 4.—E. F., æt. 26, G.P.O. guard, under the care of Mr. Walsham.

History—Present condition.—*22nd April*, 4 P.M.—Patient was struck on the head by a heavy letter-bag. Noticed nothing, except headache, until 7.30 P.M. that day, when he complained of feeling something "burst in his head," and became faint.

Present condition.—Patient lies in a semiconscious condition, but can answer questions when roused. Pulse 44, bounding. Pupils equal. Corneal reflex lost in left side only. Paralysis of left side, and attacks of rigid spasm in limbs.

24th April.—Patient is more drowsy; left pupil larger than right; has had twitchings on the right side. Temperature on right side, 98°·4; on left, 98°·6. Patient was trephined over fissure of Rolando on right side. Dura mater tense; no pulsation. Dura mater incised; a small quantity of blood escaped.

Patient's pulse went up from 44 to 120 at once, and respiration ceased. Artifical respiration was performed, and the right ventricle was aspirated, half an ounce of blood being drawn off. The wound

was sewn up. Artificial respiration was kept up for five hours before the heart stopped. Patient never breathed naturally during the whole time.

Post-mortem.—A small quantity of blood found beneath the pia mater. Brain.—At the junction of the right temporo-sphenoidal, occipital, and parietal lobes, there was a ragged hole leading into a cavity as large as a walnut, situated immediately below the cortex. This was full of blood-clot. A ragged cavity, 2 in. in length, was found to extend forwards from this; the blood had burst into the lateral ventricles. No evidence of any disease of brain substance or vessels.

Professor Macewen of Glasgow referred briefly to cases illustrating the peculiarity in question, in his work on "Pyogenic Infective Diseases of the Brain and Spinal Cord," published in 1893; and in several of the cases related in this work there were observed depression of respiratory function, together with a slowing of the cardiac action. In his lectures at San Francisco in 1896, he reported cases where the pulse-rate was lowered to forty and twenty in the minute, as the intracranial pressure increased. He noted the occurrence also of modified respiration, somewhat of the Cheyne-Stokes type, in cases of abscess of the cerebellar fossa, leading to death from pressure on the respiratory centre, the pulse remaining quick and strong. In one case artificial respiration was carried on for twenty-four hours, the pulse never flagging all the time.[1]

Professor Macewen informs me that he has lately met with two cases, in each of which the breathing was re-established after hours of artificial respiration, and in one of these he opened and evacuated a cerebellar abscess while artificial respiration was being practised. In this case the relief of the cerebellar pressure greatly improved the general condition, and soon afterwards the respiration became voluntary. The patient recovered temporarily, dying from cardiac failure, probably due to exhaustion. The restored breathing continued perfect to the end of life.

Professor Macewen has observed this phenomenon in a case of apoplexy, and in a very peculiar one, in which the brain centre was active, but where the respiratory apparatus was destroyed by a crush, the heart continuing to beat, and producing at each impulse a crackling of the broken ribs.

Mr. Victor Horsley called attention to cases of this kind in a paper published in the *Quarterly Med. Journ.* for July 1894, referring to the fact that patients suffering from cerebral hæmorrhage, cerebral tumours, depressed fractures of the skull, and sudden and violent concussion, especially when applied in the occipital region, die from respiratory and not from cardiac failure, as is often supposed; and he quotes Dr. Hilton Fagge's observation that some patients with cerebral tumour or abscess die from

[1] *Occidental Med. Times*, San Francisco, November 1896.

failure of the respiration.[1] He also points out that Leyden demonstrated, in 1866, the effects of increased intracranial pressure in slowing the pulse, causing stertorous respiration and arrest of the latter.[2] Horsley and Walter Spencer confirmed these researches, and Leonard Hill has since reconfirmed them.

Horsley's clinical studies show that, in cases of cerebral tumour, hæmorrhage, and inflammatory foci, death is apt to occur suddenly from arrest of the respiration, and that such is the common end of all cases of pathological intracranial tension, especially when the disease is extremely chronic. He offers the suggestion that, in cases where patients fall apparently dead after sudden blows on the head, and are believed to die from cardiac failure, the real cause may be an arrest of the respiratory function, and possibly remediable by the practice of artificial respiration.

Direct experiments prove that bullet wounds of the cerebral hemispheres are followed by arrest of the breathing, and that recovery may follow when artificial respiration is employed, provided no hæmorrhagic pressure is exercised upon the respiratory centre. Again, in death by hanging, the function of respiration is suspended before that of the circulation.

The temperature in the foregoing cases was chiefly noteworthy in respect of the absence of pyrexia, save in the third instance. The tendency in all was towards subnormal temperatures, and in the case in which the highest figure was reached there was a rise from 96°·8 to 102° within sixteen hours, and operative procedures were begun at that time. These low temperatures are noteworthy in view of the several processes which were in progress within the skull. This thermic depression is, however, now well recognised in the secondary stages of cerebral abscesses, and is a feature of such cases. With the cessation of respiratory function we might expect a marked reduction of temperature, to an even greater degree than occurred in these cases. In my case there had been a free employment of phenacetin, which might have further reduced the temperature.

The occurrence of suspended respiration for several hours in the highest mammalian organism, together with that of continued circulation of the blood for long periods, is very remarkable. Respiration may be carried on in animals which have been depleted of their blood and have had water introduced in place of it. But, in fact, with respiratory cessation, death has practically already begun; and the respiratory centre, unless relieved of undue pressure, ceases to act. Although in such close proximity to the cardiac centre, the former is clearly much the more sensitive of

[1] "Principles and Practice of Medicine," 1886, pp. 526 and 551. In one case the respiration ceased thirty-five minutes before death; in another, of multiple cerebral abscess in the posterior and middle lobes, the breathing stopped ten minutes before death occurred.

[2] *Virchow's Archiv*, 1866, Bd. xxxvii.

the two, and lesions involving both tell primarily and with most force upon it. We may take it that the respiratory centre is the first to give out, and that it is the most vulnerable of all the great organic nerve-centres, the first to resent undue intracranial pressure.

The clinical lessons of cases such as I have described are the following:—

1. That efforts be made promptly to relieve intracranial pressure by trephining and probing.

2. To maintain artificial respiration diligently as long as necessary; that is, until the respiratory centre can resume its function independently.

3. To regard a lowered temperature as no contra-indication of purulent foci or hæmorrhagic foci in the brain.

The fact of depressed or normal temperature is as significant in these cases as is the same occurrence in many examples of purulent peritonitis.

I desire to express my thanks to my hospital colleagues for kindly allowing me to make use of their cases for this communication.