say, with preponderance of activity on one side), and (3) as they serve in unilateral actions. But I suppose, too, that those movements which are "bilateral" are represented most nearly equally in right and left halves; that those which are "alternate" are represented less equally in the two halves (those of the left side more in the right half), and that those which are "unilateral" are represented most unequally in the two halves (those of the left side most in the right half). We must bear in mind that movements are spoken of, for the so-called alternate muscles may serve in bilateral movements; they may serve with a great degree of preponderance on one side approaching unilateral movement; and the most unilateral muscles may serve in bilateral movements.

It may, however, be asked, Where is the paralysis corresponding to abrogation of the second and third sets of fibres from the right "motor region?" The existence of some weakness of the right side (the so-called non-paralysed side) has been urged by Brown-Séquard, Pitres, Friedlander, and Gowers; but when in the difficult circumstances attending investigation of the state of the right side no disability is demonstrable, there may yet be loss of some few movements of the muscles of that side. The loss of these few movements is masked by the compensation given by the left half of the brain, which represents most numerous movements of the right side. If we take the case of excessive discharge beginning in some part of the right middle motor centres, we find that, in severe epileptiform fits, both sides of the body are convulsed. In this case compensation is "inverted," that is to say, centres which would compensate a loss are compelled to co-operate in an excess. The comparison and contrast of hemiplegia and an epileptiform seizure are, however, by no means simple, as we shall see when the process of universalisation of an epileptiform convulsion is considered.

Although when speaking of the hierarchy of nervous centres I excluded from consideration the higher divisions of the cerebellar system, it is necessary to say something of them. There are in some cases of tumour of the median lobe of the cerebellum, seizures very like, if not quite like, those of ordinary surgical tetanus. I have suggested that the convulsion of surgical tetanus is owing to cerebellar discharges; but no doubt the poison causing that morbid affection affects lowest centres too. It has been suggested that the tetanus-like seizures in the cases of cerebellar tumour mentioned, are owing to pressure upon, or to changes induced in, the corpora quadrigemina or medulla oblongata, or both. But surgical tetanus is, at all events, in order of development of spasm over its regional distribution the "complementary inverse" of epileptiform seizures. And when we consider nervous diseases, each as a flaw in a whole nervous system, the study of "corresponding opposites" is most important. There is a more direct reason for taking note of the cerebellum in the present inquiry. What the structures are connecting the cerebellum with the lowest motor centres I know not. If there be a connection—if the lowest level is at once the lowest level of the cerebral and of the cerebellar system—we may expect the higher levels of the cerebellar system to be concerned in post-epileptiform states; the question is important, especially with regard to increased tendon reactions in post-epileptiform paralyses. I have suggested¹⁹ that the cerebellum is concerned with the rigidity and exaggerated tendon reactions of (left) hemiplegia²⁰ when that paralysis is the result of a destructive lesion of the (right) internal capsule, that there is not only exaltation of function of the (left) lowest motor centres from loss of control, but also that the cerebellar influx upon them is no longer antagonised. This hypothesis has been objected to on the ground that in transverse lesions of the upper dorsal or cervical cord (the cerebellum being thus excluded) there is nevertheless rigidity of the legs with exaggerated knee-jerk and foot clonus. I was obliged to admit that the cerebellum is not necessary for the production of the exaggerated jerk and rigidity.²¹ But Charlton Bastian,²² who has advanced proof where I only speculated, has found that, in man, on complete transverse lesion of the regions of the cord mentioned, the muscles of the legs are flabby and the knee-jerks absent; what is very striking, he finds that the condition of rigidity of the legs and exaggerated knee-jerk in cases of incomplete transverse lesions changes to one of flaccidity with no tendon reactions when that lesion becomes

completely transverse. If Bastian be correct, as I think he is, the hypothesis of cerebellar influx, on which we are in fundamental agreement, is supported.

THE TREATMENT OF SUPPURATIVE INFLAMMATION OF THE MASTOID PROCESS ASSOCIATED WITH DISEASE OF THE MIDDLE EAR.

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My object in writing this short paper is to advocate no very novel mode of treatment, but to illustrate by a few cases the advantage of adopting as early as possible such radical surgical measures as not only remove the patient from the risk of septic infection and intracranial suppuration, and prevent the possibility of a recurrence of the inflammation in or about the mastoid process, but also serve to cure the inflammation which has become chronic in the middle ear and probably influenced the function of the internal ear, and in a very considerable proportion of cases to restore to the patient an amount of hearing power so great as to render any deficiency imperceptible to a non-professional observer. This last advantage has impressed me very greatly, imbued as I was with the belief that the presence of the small bones of the middle ear and the membrana tympani were necessary for fairly acute hearing. Over and over again, as the following cases will show, patients have, after the removal of the mastoid antrum and the contents of the middle ear and the subsidence of the inflammation, recovered very good hearing power. These cases will also serve to illustrate the frequent presence of a large antral cavity in such as suffer from chronic abundant middle ear discharges, and especially when associated with inflammation of the mastoid process.

Given a large antrum filled with foul caseous and purulent material, and discharging its overflow of extremely irritating material into the sensitive mucous lining of the middle ear, it is perfectly obvious that this condition cannot subside or disappear if left to Nature, while its presence is not only a source of great danger to the life of the individual, but also to the integrity of the internal ear. This antral cavity, when well developed, is of considerable size, and is in immediate relation with the posterior and middle fossae of the skull, the lateral sinus, the middle ear, the external auditory meatus, and the outer surface of the skull, in all of which directions pus may make its way through an aperture in the bony wall of the cavity, or it may determine the development of an acute suppurative periostitis between the cartilage of the auditory meatus and the bone or over the outer aspect of the process, or between the dura mater and bone in the middle or posterior fossa, and associated or not with the last it may produce thrombosis of the lateral sinuses. I am convinced that it is this antral distension which forms the chief source of the above, and that it is comparatively rarely that the penning up of pus in the middle ear is the chief factor, for the reason that the external auditory meatus is not easily completely occluded.

The mastoid antrum varies within very wide limits, not only in form and size, but in its relation to adjoining surfaces. It would appear, as one would expect, that suppuration in and about the mastoid process takes place more readily in such subjects as have well-developed antral cavities, and this is especially the case in those who are affected by recurrent attacks of inflammation. Pathologists appear to be unaware of the importance and the anatomy of the mastoid antrum. How rarely does one see its condition described in the record of a fatal case of intracranial mischief. Usually the observer is satisfied with opening the roof of the middle ear and finding pus, or with exposing the mastoid cells in the apex of the process. My experience would lead me to conclude that the antrum is a much greater source of danger to the cranial contents than are the mastoid cells.

As I have already stated, by no means the least advantage of the operation to the patient is the opportunity it gives of removing a *cul-de-sac*, which without operation could never be drained, and without the removal of whose foul and irritating contents the inflammation of the middle ear, and the absence of function of the internal ear, could never be removed. It also enables the middle

¹⁹ *Medical Examiner*, April 5th, 1877, and March 29th, 1878.

²⁰ Not rarely both knee-jerks are exaggerated; this perhaps helps to show that the third set of fibres ends in the right lowest motor centres.

²¹ *Medical Times and Gazette*, February 12th, 1881.

²² *Quain's Dictionary of Medicine*, p. 1481.

ear to be flushed by a thorough stream frequently, its secretions to be removed, and its inflammation to disappear.

I feel so strongly that the overflow from a foul distended mastoid antrum is so frequently the cause of a chronic inflammation of and an abundant foul discharge from the middle ear, that if I find such discharge associated with a history of pain or tenderness about the mastoid process, I do not hesitate to open up the mastoid antrum and establish a thorough drainage for perfect irrigation. As regards the operation, I think no instrument is so safe as a sharp gouge. The great variation in the form and position of the antral cavity and the vicinity of the lateral sinus makes the trephine a most dangerous instrument for this purpose, and I think it should never be used. With a gouge one can remove a layer of bone of extreme thinness, and by means of this instrument, with moderate skill, it is impossible to do any harm.

The chief difficulty in this operation consists in establishing a communication of sufficient calibre between the middle ear and the antrum (should, as is usually the case, the communication be insufficient), and in doing this great care must be exercised in avoiding any damage to the facial nerve and to the inner wall of the tympanum. I have as yet avoided any injury to these structures, though from the report of case W.A. it is obvious that the risk is a considerable one. The most moderate care would render it impossible to injure the lateral sinus, though remembering the great variations in the antrum one cannot be too careful in the gradual removal of bone.

If there is any suspicion of intracranial mischief, the subdural spaces of the middle and posterior fossæ, any portion of the brain likely to present suppuration in consequence of disease of the ear, and the lateral sinus can be thoroughly explored through the limited surface of bone exposed, which need not exceed an area larger than a halfcrown.¹

H. V., a boy, aged 12½ years, had foul discharge from the right ear for more than four years. Some months ago an abscess formed behind the right ear and burst. It healed up, but the place has been tender since. The discharge from the meatus became more foul and profuse. He was admitted under my care on August 7th, 1889, with great pain and tenderness on the right side of the head, and especially about the mastoid process, over which the skin was red and inflamed and fluctuating. Temperature 102°. There was a profuse discharge from the meatus, and the boy appeared to be quite deaf in this ear. He stated that this deafness had been noticed for some time.

The same day the boy was put under chloroform and the middle ear examined. The membrana tympani was almost absent. The soft parts were raised from the mastoid process, which was bathed in foul pus which continued to escape from a minute aperture in the bone situated about half an inch behind and a little above the external meatus. On removing a thin layer of bone which formed the whole outer wall of the antrum, into which the minute aperture opened, together with its foul caseous contents bathed in pus, the cavity was found to be about the size and shape of a large cherry. A channel of suitable calibre was then cut from the antrum into the middle ear, which was then carefully scoured out. A perforated silver drainage tube, capped with rubber externally to prevent an irritation of the external ear, was fixed in what was the antral cavity, and the middle ear was irrigated several times during the day with a through current of lotion.

As the antrum was a large one, in order to allow it to fill up from the bottom the tube was not removed till February, 1890, and within a week the sinus which it occupied closed. There was then no discharge from the meatus, in which the lad wore one of Dr. Ward Cousins's artificial drums, which improved his hearing considerably, while it prevented cold air from entering. He could hear a low conversation readily and a watch ticking at a distance of three inches.

G. V., boy, aged 3 years, had a foul purulent discharge from the right ear for the last year. A month ago a swelling formed and burst behind the right ear. This had continued to discharge since.

He was admitted under my care on October 2nd, 1889. There was offensive discharge from the meatus and from the sinus. The child was apparently deaf in that ear. On exposing the mastoid process a minute aperture in the bone was seen situated a little behind the meatus, and corresponding in level to its upper border; it led into a cavity of considerable size. The whole outer wall of this cavity was completely removed with a gouge, and it was

then found to be filled with foul smelling caseous material. It was a smooth walled cavity, as in the last case, and about the size of a small marble. As there was not a sufficient communication with the middle ear, a channel was cut into the latter cavity, which was then thoroughly cleaned out. A perforated silver tube was then fixed into the floor of the antral cavity, and frequent irrigation was pursued.

The child left the hospital on November 20th with only a very slight discharge. When seen last on February 15th, 1890, he could hear ordinary conversation with his right ear, and had for some considerable time ceased to have the slightest discharge from the meatus, or from the sinus left by the tube. This had closed a few days after the tube was removed.

W. A., boy, aged 9 years, for two years has suffered with otorrhœa and pain in the right ear with exacerbations, accompanied with pain and swelling behind the right ear. At times he was "light headed" with the pain and fever.

On September 22nd he had an unusually severe attack, and on the 28th he was admitted under my care. There was an extensive fluctuating swelling covering the right mastoid process, and extending for two inches around. There was very little discharge from the meatus, which was swollen. The cervical glands on the right side were swollen and tender. The ear was apparently quite deaf. There was much headache, especially on the right side; no optic neuritis. The mastoid process was freely exposed, and a quantity of foul pus evacuated. It was apparent that the pus had escaped between the cartilage of the meatus and the bone. The antrum was exposed fully with the gouge, and a cavity more than half an inch in diameter, and filled tensely with foul smelling caseous material and pus was exposed. A small channel was then cut into the middle ear, which was also found to contain cheesy material. This was removed, and the cavity cleared out. A silver tube was fixed in the antral cavity, and daily irrigation pursued.

On the third day after the operation, some paresis of the right facial muscles was observed. This became more marked, then subsided and disappeared within ten days of its onset. It was obviously due to inflammation set up by the operation, and not to any injury of the facial nerve in the bone.

On November 3rd the boy left the hospital wearing the tube, and with only such discharge from it as would be caused by the irritation of its presence.

When last seen on February 18th the boy could hear ordinary conversation with his damaged ear. The father said: "He is now a different boy, and is not stupid as he used to be before the operation." There was no trace of the facial paralysis.

As an instance of the less frequent condition of mastoid suppuration, where there is no definite antrum but a larger number of mastoid cells extending upwards beyond their usual limit and filled with foul pus, I would quote the following case, but before doing so I would point out that in mastoid suppuration the mastoid cells may be perfectly free of pus, while the antral cavity is filled with it in its foulest condition. On more than one occasion I have, on finding the mastoid cells apparently healthy, felt disinclined to proceed further, but in these cases a more extended operation was rewarded with complete success.

R. W., boy, aged 3½ years, had a discharge from the left ear since teething. On September 4th, 1889, the child was attacked with pain and swelling behind the affected ear, and on the 10th he was admitted under my care, with a large fluctuating swelling covering the mastoid process and extending around it. The mastoid process being freely exposed and much pus evacuated, it was obvious that the pus had escaped from between the mastoid process and the cartilage of the meatus. A probe passed between the mastoid process and cartilage of the meatus did not enter the middle ear. The membrana tympani was practically absent, and there was no obstacle to the free escape of pus through the meatus. On removing the outer wall of the mastoid process many small cavities were exposed. They were tensely filled with foul pus, which welled out freely from them. These spaces were completely removed with a gouge and sharp spoon. No definite antral cavity was found. A channel was cut into the middle ear, which was cleared of its purulent contents, and a silver tube was inserted. Frequent irrigation was adopted, and the child left the hospital on September 24th with a very slight discharge from the meatus.

When last seen on February 15th the child had long ceased to have the slightest discharge, and could hear with his left ear ordinary conversation without any apparent difficulty.

¹ Five Cases of Complicated Disease of the Middle Ear, *Trans. Clin. Soc.*, 1888.