pathological urobilin. It is formed, not only by processes of reduction or oxidation from the bile pigments within the intestinal canal, but also I find evidence to show from hæmoglobin through the agency of cells. Between it and normal urobilin important differences exist. Its appearance in the urine in pernicious anaemia points therefore—far more than any excess of ordinary pigments—to a preceding extensive destruction of blood of a special nature. It does not explain the presence of iron in the liver, any more than the excess of iron in the liver explains its occurrence. Both alike are, however, explained by the same special cause—a destruction of blood proceeding along lines, and due to causes, other than those found in health. I concluded in my former investigation that the destruction was caused by the action of certain poison or poisons of specific nature. It was the object of my investigations to discover in the present case whether any such poisons were present.

2. My observations on the urine in the above case showed, secondly, occasional presence of blood pigment in the form of granules enclosed within cells of renal origin. For a time these pigment cells were absent, and their absence corresponded with the period during which ground was being regained. They reappeared, however, in increased numbers on each occasion of an exacerbation of his weakness. The cells and pigment granules present in the urine during life were identical with those I found in the tubules of the kidneys after death; and their origin from the latter cannot, therefore, be doubted. The significance to be attached to their presence I have elsewhere fully discussed.

3. They showed, lastly, an increased excretion of iron. In three cases of chlorosis I found the average excretion of iron in the urine *per diem* 1.76 milligrammes, and in health 5.65 milligrammes. The average daily excretion of iron in the urine in health I estimate to be from 3 to 5 milligrammes. Three weeks before the patient's death in the above case, at a time when the anaemia was most intense, I found the excretion to be so high as 32.26 milligrammes; a week before death it was 6.52; and two days before death it was still 1 milligramme.

So far as I am aware, no previous observations have been made on the excretion of iron or the presence of renal cells containing blood pigment in this disease. Taken together with the large increase in the urinary pigments, and especially with the presence of pathological urobilin in the urine, they pointed clearly to a preceding excessive destruction of blood, the amount of destruction, as evidenced by the varying colour of the urine and excretion of pigment, varying from time to time.

These clinical observations in the present case bear out fully the conclusions it was one of the main objects of my former investigation to establish as to the essentially hæmolytic nature of this disease. The changes found after death in liver, spleen, and kidneys point equally to the same conclusion. The situation and character of the pigment within the liver were such as I have formerly described. The pigment was more abundant in the present case than in any I have yet met with; and I have now examined the liver in thirteen cases of this disease. The enlargement of the spleen recognised during life and confirmed *post mortem* is of some interest in connection with the important part played, as my observations show, by that organ as one of the chief seats of blood destruction both in health and disease. The congested purplish appearance presented by the pulp was the same as that found by me in another case I have described. It was also due apparently to the same cause—not to the presence of red corpuscles, few of which were to be found, but to the presence of free hæmoglobin. The presence, also, of well-formed crystals, presumably of hæmoglobin, is also of special interest in connection with the interesting observations of Dr. Copeman⁵ as to the readiness with which crystals of hæmoglobin are obtained from the blood in this disease.

(To be concluded.)

⁵ St. Thomas's Hospital Reports, 1887.

MALE NURSES.—The annual meeting of the Hamilton Association for Training and Supporting Male Nurses was held on June 28th, at Park Street, Grosvenor Square. Amongst others who spoke of the capability of the fifty nurses attached to the Society, either ex-army staff assistants or hospital trained nurses, were General C. E. Gordon, C.B., Sir William MacKenzie, and Dr. Prosser James. The balance sheet proved highly satisfactory, and the Society owes much to the liberal founder, Miss Hamilton.

THREE LECTURES ON SOME POINTS RELATING TO INJURIES TO THE HEAD.

Delivered at the Royal College of Surgeons of England.

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LECTURE I.

MR. PRESIDENT AND GENTLEMEN,—I have taken as a title for the lectures which I am about to give, "Some Points Relating to Injuries to the Head," and purpose asking you to consider with me, more especially, the effect of injuries when fracture of the cranial base has been produced, with some of the complications which are only too liable to accompany these fractures, or follow at a longer or shorter interval after the force producing them is expended.

For several years, in various official capacities, I had the privilege of seeing the surgical practice of St. Thomas's Hospital, and of closely observing, amongst other cases, many of injury to the head; and through the kindness of the members of the surgical staff of that hospital, I am enabled to bring before you a series of the cases which were under care in that institution during a part of that time, and can thus present a comparatively large number of examples for consideration. To these I have added the results of experience obtained at the Royal Free Hospital or elsewhere.

I have made a summary of most of them, and it will be to cases in this group that my remarks will refer, unless mention is made to the contrary.

TABLE I.—Non-fatal Cases of Fractured Base.

	Males.	Females.	Ages in Years.										Total.
			Under 5	Under 10	Under 20	Under 30	Under 40	Under 50	Under 60	Under 70			
Anterior fossa	16	5	—	3	3	6	3	4	2	—	—	21	
Middle "	59	6	3	4	8	16	13	6	5	1	—	56	
Posterior "	10	1	—	2	2	—	4	2	1	—	—	11	
Middle and anterior fossæ ...	15	5	1	4	2	4	5	3	—	—	—	20	
" posterior "	4	1	—	—	—	2	1	2	—	—	—	6	
Anterior, middle, and posterior fossæ	1	—	—	—	—	—	—	1	—	—	—	1	
Total	96	18	4	13	15	28	26	18	8	2	—	114	

Fractures of the base of the skull may be produced by direct or by indirect violence. Examples of the former are afforded by (1) thrust wounds usually of the orbit or nose; (2) a blow on the chin, driving the condyle of the lower jaw through the glenoid fossa, as shown by a preparation in the museum of St. George's Hospital; (3) a blow on the nose, fracturing the bones which enter into its formation, and the cribriform plate of the ethmoid. The fracturing force may also be conveyed through the condyles of the occipital bone, either from a fall on the buttocks or feet, or as the result of the impact of the body weight on the condyles in a fall on the head. Two opposing forces will also produce a fracture, sometimes limited to the central bones of the base. They may also be caused by *contrecoup*, but are most commonly the result of extension of a fissure from the vault into a fossa on the side to which the violence is applied.

They may also be compound, either as the result of the force acting at the point struck, or from their extension into cavities which communicate with the external air; for this reason the majority of fractures of the base of the skull are compound when they are in the middle fossa, through implication of the middle ear, also a large number of those in the anterior fossa from extension of the fracture through the cribriform plate into the nose.

As a rule, when they extend into the base from a fissure of

the vault, the fracture in the base retains that character, but it may present some comminution, a not unusual circumstance when a fracture of this region has been produced by direct force.

TABLE II.—Fatal Cases of Fractured Base.

	Males.	Females.	Ages in Years.										Total.
			Under 5	Under 10	Under 20	Under 30	Under 40	Under 50	Under 60	Under 70			
Anterior fossa	4	3	—	—	—	—	2	2	2	1	7		
Middle „	13	1	1	1	1	5	5	1	—	1	14		
Posterior „	10	—	1	—	1	2	2	1	1	1	10		
Middle and anterior fossæ ...	2	1	1	—	—	1	—	—	—	—	3		
„ „ posterior „ ...	8	3	2	1	1	1	1	1	2	2	11		
Anterior, middle, and poste- rior fossæ	5	1	—	—	—	1	2	1	2	—	6		
Posterior and anterior fossæ...	—	1	—	—	—	—	—	1	—	—	1		
Both middle fossæ	1	1	2	—	—	—	—	—	—	—	2		
Non-fatal	43	11	7	2	3	10	12	8	7	5	54		
	96	18	4	13	15	28	26	18	8	2	114		
Total	139	29	11	15	18	38	38	26	15	7	168		

I have here a table showing the result of an analysis of fifty-four of the fatal cases which have been under my observation, and in which the situation of the fracture was demonstrated on *post-mortem* examination. They were most of them fissured fractures, and do not include punctured fractures of the orbit or occipital region. If we, like Dr. Aran,¹ divide the skull into three zones or segments, an anterior zone formed by the frontal, the upper part of the ethmoid and the fronto-sphenoid; a middle zone by the parietals, the squamous and the anterior surfaces of the petrous portions of the temporals, with the greater part of the basi-sphenoid; and a posterior zone, including the occipital, the mastoid, and the posterior surfaces of the petrous portions of the temporals, with a small part of the body of the sphenoid, we find that out of 31 cases the line of fracture was strictly limited to the anterior in 7, to the middle in 14, and to the posterior in 10.

When two fossæ were implicated in a fracture, the middle fossa, from its position and connections, was necessarily the one most frequently affected; thus, in 11 the middle and posterior fossæ were involved, and in 3 the middle and anterior. In two instances a fracture extended across the middle fossa from side to side, so that on removal of the skull cap the halves could be freely moved on one another.

In only 1 was there fracture in the posterior and anterior fossæ, the anterior being apparently caused by *contrecoup*.

In 6 the three zones were all affected. In one instance this was not from continuation of the same line of fracture, but the right posterior, right anterior, and left middle fossæ presented isolated fractures. The patient had been struck by a cart that was being driven quickly along, and thrown on the kerb; there was, therefore, a sufficient explanation. Usually the line of fracture is arrested if it meets with one of the foramina in its course, especially if the foramen is a large one. But here is a diagram (Fig. 1) which illustrates a curious condition, and one of much rarity—a fracture extending across the base to the foramen magnum, starting again on the opposite side of the foramen. Vibrations must have been conducted round the bony margin of the foramen, and become amplified where they met after completing the circuit to an extent sufficient to produce fracture. The structures occupying the foramen were uninjured. Fig. 2 shows an unusual result of a blow on the left side of the occipital bone. The force which caused the injury was so severe that fractures are found extending much in the same direction—obliquely across the base from the point struck, but each is limited in extent, and commences in a different line to the preceding one.

We have most of us read with pleasure Hilton's² "Notes on Some of the Developmental and Functional Relations of Certain Portions of the Cranium," and have been struck with the explanation which he gives of the uses of the cranial eminences, their usefulness in the conduction of vibrations which have been transmitted to the skull to points where, from the nature of the surroundings, these vibrations are least calculated to do harm by extension to the brain. In the anterior fossa they are communi-

cated from the part struck to the anterior clinoid processes which, in the normal relationship of parts, are attached to membrane and surrounded by cerebro-spinal fluid, in which the vibrations are lost. In the middle fossa, the petrous portions of the temporal bone being separated from the basilar process by the intervening layer of soft or membranous structure, the vibrations conducted in this direction become here also obstructed without transmission to the brain, or the bone beyond. In the posterior fossa, vibrations are conducted from the spine to the occipital condyles, along the jugular process to the petrous bone, along the basilar process to the posterior clinoid processes, which are surrounded by cerebro-spinal fluid, along the ridge of the foramen magnum to the internal occipital protuberance and longitudinal and lateral ridges. Vibrations, started by a blow on the back of the head, are also conducted to the posterior clinoid processes to the petrous bone, and along the vault to the crista galli in front.

Fig. 1.—Fracture of the base of the skull extending across the foramen magnum.

Thus, alighting on the feet or on the knees in a fall from a great height³ gave rise in one instance to a breaking up of the apex of the petrous bone and of both posterior clinoid processes; in another instance, to a fracture also of the right petrous bone and

Fig. 2.—Fracture of the base of the skull dependent upon injury to the left occipital region.

a slight fracture of the same side of the sella Turcica; and in a third instance, the only bone broken about the skull was the cribriform plate of the ethmoid.

¹ Arch. Gén. de Méd., iv série, t. vi.

² Selected and edited by Dr. Pavy.

³ Sir Prescott Hewett; Mr. Hulke; Holmes's *System of Surgery*, vol. i, p. 587 *Jour. de l'Exér.*, 1843; *Bull. de la Soc. Anat. de Paris*, 1848, pp. 193, 268.

In a similar way may be explained the following cases: A woman, aged 62, fell down stairs, knocking her left eyebrow. She died apparently from shock, and at the *post-mortem* examination the lesser wing of the sphenoid on the left side was the only part within the cranium that had sustained injury, and that was splintered.

A woman, aged 55, died in a similar way, after having been thrown from a hansom. She had received a wound over the eyebrow, and at the *post-mortem* examination it was found that there was no fracture of either spine or skull, excepting of the anterior clinoid process of the sphenoid on the side corresponding to the wound.

In another, a man, aged 29, who died with extensive fracture of the vault, extending from back to front, along the left side of the base, there was a small isolated portion of the roof of the tympanic cavity loosened, and easily removed with the forceps. The main fracture ran some distance away from it and in another direction.

With regard to the separation of sutures at the base, it was not uncommonly found that the line of fracture ran into one of the sutures and caused separation, but at no *post-mortem* examination was the fracture limited to a suture; it always extended into a bone beyond. The sutures between the occipital and other bones were most commonly separated. In one case, that of a child aged 3½ years, who had been run over, in addition to fracture of the middle fossa, there was separation of the squamo-parietal suture on each side.

I have not met with fracture involving the apex of the orbit to an extent at all like that stated by Van Hölder.⁴ He says that in 54 out of 88 instances of fractured base there was injury to the optic foramen, but in 42 out of the 54 the injury had been from gunshot. This still leaves 12 instances of the fracture of a simple character, making a proportion quite beyond what the records of our *post-mortem* rooms or pathological museums afford in this country.

It is a recognised fact that fractures of the base may unite perfectly, but there are many examples extant of imperfect union, the uniting medium being only fibrous tissue. Two cases which recovered from the fracture to a greater or less extent died some months after from other causes, and in both there was good bony union; but the line of fracture remained very distinct. The following cases illustrate what was probably a second fracture of the base:—

A coachman, aged 26, was admitted under the care of Mr. Sydney Jones in 1881. He was insensible, and vomited continuously for two days, during which time free bleeding from both ears continued, and the pupils were widely dilated. On the cessation of the bleeding a thin watery discharge from the right ear followed, and only ceased six days later. Deafness in that ear remained. Three years earlier he had had a similar injury to the head, with profuse bleeding from the right ear.

A man, aged 33, was admitted under the care of Mr. MacKellar on July 11th, 1886. He had been found by the police lying insensible in the street. He was unconscious, with hæmorrhage from the right ear. He remained unconscious for some time, with a pulse of about 60, and on the third day his temperature was only 96.8°, and was frequently subnormal after this during his stay in hospital. It appeared from the statements of his friends that he had been in Guy's Hospital from March 30th to May 12th of the same year; and Mr. Parkin, the surgical registrar, has kindly written to me about him. He was admitted under the care of Mr. Durham, suffering from the effects of a fall, quite insensible, and bleeding from the right ear; the pupils were contracted and small. Pulse 80, weak; respirations 16. Soon after admission he had a convulsive attack, moving his head and drawing his legs up. Four hours after admission he became sensible. He had other epileptic seizures during his stay in hospital. He had been subject to "attacks of giddiness" between times.

Let us consider the symptoms on the presence of which we have to depend for the diagnosis of fracture in one or more of the fossæ into which the base of the skull is subdivided. The symptom most commonly met with—and the one on which we rely, more especially in those cases which come under our notice soon after the infliction of the injury—is hæmorrhage from the seat of fracture, and its appearance in the neighbouring tissues, or its escape from the nose, the mouth, or the ear, and not infrequently its presence in the matters ejected from the stomach.

The great vascularity of the mucous membrane of the nose

renders it liable to bleed readily when injury has been done to the anterior part of the head by a fall or blow, which may have caused a laceration of the mucous membrane lining it, or a fracture of some of the bones entering into its formation; and it is necessary to examine as to the local effect of an injury and the presence of other indications before epistaxis can be regarded as a useful sign. In the cases in which fracture of the anterior fossa was diagnosed, 16 had hæmorrhage from the nose, but in the majority this was combined with other symptoms, such as hæmorrhage to a greater or less extent into one or both orbits, or from the mouth; and in those instances in which there was reason for suspecting a fracture of the middle fossa also, it was present in 15. In one patient the hæmorrhage from the nose continued for three days; in another it was very free when lying on the left side, and continued for four hours. As a rule, it was profuse at first, and did not recur; but one patient had a return on the second and fourth days after the injury, and another on the fifth and seventh days. In the fatal cases it was a symptom in 16, but in only 9 was any fracture of the anterior fossa found at the *post-mortem* examination.

Hæmorrhage from the mouth is also unreliable unless accompanied by other signs. This symptom was present in ten cases, in five of which fracture of the lower and in two fracture of the upper jaw was found. Of fatal cases, nine had bleeding from the mouth; and of these, one was dependent upon fracture in the anterior fossa involving the cribriform plate, accompanied by fracture in the middle fossa. Once the bleeding was free, and appeared to be arterial, for it was of a bright cherry-red colour, and profuse. In some of these the blood probably came from the mucous membrane of the pharynx, but the difficulty in examination of the fauces and pharynx during the period that this symptom is met with is great, and I can offer no definite statement from personal observation. In a case recorded by Dr. Aran⁵ the bleeding came from a rupture of the internal jugular vein. Hardly separable from these two signs—hæmorrhage from the nose and mouth—is the appearance of blood in the vomit; and whenever this was sufficient to attract attention one or both of them was present, sometimes to a marked extent. Once the vomiting continued the whole of the first day, and the quantity of blood in the vomited material was large; on another occasion a patient vomited blood on the sixth, seventh, and eighth days after admission without apparent cause. The possibility of its being a symptom of pre-existing disease of the digestive tract must be borne in mind, though such a complication is undoubtedly very rare. The blood vomited occasionally has the appearance of "coffee grounds" if it has been retained in the stomach for some time, and so simulates more closely the hæmorrhage of some forms of gastric disease.

Hæmorrhage from the ears is acknowledged to be a most important sign of fracture in the middle fossa; this applies more especially when the bleeding is copious and sustained. Thus, of the fatal cases of fracture involving the middle fossa only, there was bleeding from the ears in ten out of the thirteen, and the amount of blood lost varied considerably; most commonly it trickled from the ear, but was computed at 30 ounces in a short period of time in the case of one patient whose clothes were saturated with blood, and was present in eleven where the fracture involved other fossæ as well as the middle fossa. Most of the cases recovered in which the fracture was supposed to be in the middle fossa, and the diagnosis of the position of the fracture was largely based on the occurrence of hæmorrhage from the ear. Thus, out of eighty-two, blood came from the right ear in thirty-two, from the left in thirty-three, and from both ears in nine. Not infrequently the hæmorrhage recurred; this happened in different patients as late as the fifth, sixth, and seventh days respectively. At no time did it last longer than a week after admission, but flowed freely for the whole of that time in one. In one of the patients it was considered advisable to examine the condition of the membrana tympani on the second day to see whether it presented a rupture, but the necessary removal of the clot which blocked the external meatus produced renewed hæmorrhage, which went on for hours.

In the main these observations confirm the opinion that immediate profuse and continued bleeding from the ear is an important sign of fracture of the middle fossa, and of a fracture passing through the tympanum associated with a rupture of the membrana tympani; also that that fracture has lacerated some of the vascular channels round the petrous bone.

⁴ Graefe und Sämisch.

⁵ Loc. cit.

Mr. Erichsen⁶ says that "copious hæmorrhage from the ear to the extent of many ounces has been known to occur from a fracture of the anterior and inferior part of the meatus auditorius externus, in consequence of the condyle of the lower jaw being forcibly driven up against it, the jaw itself having been fractured." And in confirmation of the fact that this occasionally happens, I have here a specimen removed by Mr. E. C. Stabb from the body of a patient who died in the Royal Free Hospital under the care of my senior colleague, Mr. Gant, to whom I am indebted for permission to bring the case forward. In this you will see a very unusual association of fractures—fracture of the bony wall of the external meatus, and also a fracture of the petrous part of the temporal bone, but no rupture of the membrana tympani, so that although a fracture of the posterior and middle fossæ of the skull was correctly diagnosed, that in the latter position was supposed to be indicated by the bleeding from the ear, which in reality came only from the external meatus (Fig. 2.)

Other cases were observed in which after death a fracture was found in the middle fossa of the skull, and in which during life no satisfactory evidence was forthcoming as to the situation of the fracture, there being no hæmorrhage or discharge from the ear. There were eight of these. None of them involved that portion of the petrous bone which contains the auditory apparatus (Fig. 3).

Fig. 3.—Illustrating the position of some fractures which involved the middle fossa, and were not accompanied with bleeding from the ear. Sometimes there were fractures in other fossæ also, as indicated by the numbers.

Of those recovering after supposed fractured base, hæmorrhage from the ear was accompanied with epistaxis in 14 cases, with hæmorrhage from the nose and mouth in 4. In 3 fatal cases there was hæmorrhage from the nose and ear; in 2 from the nose, ears, and mouth.

A very rare phenomenon, of which I have only found two cases, is hæmorrhage from the eyes. It is a symptom to which much importance cannot be attached, and probably depends on slight laceration of the conjunctiva, but I am bound to admit that no wound was found in either case. It might possibly have escaped from the lachrymal canals. The patients who presented this symptom were both severely injured. The cases were as follows:

A man, aged 40, admitted to St. Thomas's in 1838. He had been drinking heavily, and was supposed to have fallen against a chair. He had received a severe contusion of the right eye; the conjunctiva was suffused with blood, and there was interference with the action of the internal rectus. Some blood was trickling from between the eyelids of the left eye. His pulse was very weak, and he had been vomiting. On the fifth day there was proptosis of the right eye with chemosis of the conjunctiva, and he had suffered from headache since admission. On the sixth day the edges of the right disc were indistinct, but the vessels clear. On the eleventh there was still no action in the internal or inferior recti muscles.

It was also seen in a boy, 9 years old, suffering with bleeding

from the ears and nose due to head injury. He died, and a fracture in the posterior and middle fossa was found in the side opposite to the eye from which the hæmorrhage came.

Another not infrequent and most important sign when present is the discharge of a watery fluid from the ear and from the nose, and sometimes from the vault of the skull in severe injuries of that part, accompanied by fracture of the bone. According to Robert, this symptom was noticed for the first time by Stalpartius Vander Wiel about 1727.⁷ The case in which it was observed, which presents much historic interest, was that of a woman who had received a blow from a stick over the left parietal bone. She lost such a large quantity of watery fluid from the ear during the four or five days which followed, that it was computed to amount to 300 grammes a day. She recovered rapidly on the cessation of the discharge. Van der Wiel also refers to a patient under the treatment of Langelottus, a prince who had fallen fourteen feet on his head. As the patient suffered very great pain it was proposed to trephine him, when it was noticed that there was a free flow of fluid from the ear, and the operation was abandoned.

O'Halloran⁸ saw a patient in consultation, about whom he wrote in 1760: "There also constantly oozed out of the right ear, and immediately after the accident, a clear limpid water, which might amount to at least the quantity of twelve ounces in the twenty-four hours, and which ceased not till his death." Medical progress has often been delayed by the refusal of friends to permit a *post-mortem* examination to be made, and it was so in this instance, hence the observation goes no further, for the fluid was not analysed. It was not until 1835 that a French surgeon, Laugier,⁹ showed that this discharge of watery fluid from the ear was associated with a fracture of the petrous bone and a rupture of the membrana tympani in at least one instance, and many observations since then have proved the general truth of the observation. When this point had been decided, the question arose as to the nature and source of the fluid which came from the ear, sometimes in amount sufficient to drench the pillow of the patient in the course of a few hours. Laugier himself ultimately came to the opinion that this fluid was derived from the clot of blood resulting from the fracture, and situated between the dura mater and the bone, also from the lacerated blood vessels which were on the surface of the broken bone and in the surrounding soft parts. He also considered that the presence of this flow of clear fluid indicated a fissured fracture of the base of the skull, and the presence of a blood clot over it. These views are interesting, as they appear to have been the first given to the world founded on the result of dissections in fatal cases; but, as pointed out by Robert,¹⁰ the proportion of blood found over the seat of fracture was not in keeping with the amount of supposed discharge from it; and an analysis by Chatin revealed the presence of less albumen and an amount of chloride of sodium far in excess of that met with in the serum of the blood.

Chassaignac (1850) thought that it was derived from the blood contained in the sinuses of the base through rupture or fraying of their walls. Marjolin¹¹ considered the lining membrane of the labyrinth to be the source, and Guthrie (1842) the cavity of the arachnoid. Bérard and Nélaton¹² suggested that it might be due to escape of the cerebro-spinal fluid, and Robert proved that in many instances this is so. I say in many instances because it has been proved that watery fluid to a very considerable extent may flow from the ear, and there may not be any fracture found even on the most careful examination of the petrous bone. I have not been able to find any instances which illustrate this statement better or which are founded on better evidence than those which rest on the authority of Mr. Gray and Mr. Holmes. These are well known; but the fact is important, and I must briefly refer to them.

The former communicated to the Pathological Society¹³ the account of a man, under the care of Mr. Cutler, who, after an injury to the head with a small scalp wound on the right side, had a considerable and long-continued discharge from the ear. Seven days after admission he died from diffuse inflammation of the areolar tissue of the scalp. The discharge from the ear, varying somewhat in quantity, continued from the time of his accident, when it was mixed with blood, until the day previous

⁷ *Observat. Rar. Cent. Prima, Obs. xl, Leyden, 1728.*

⁸ *Injuries of the Head, p. 120.*

⁹ *Comp. Rend. de l'Acad. des Sciences, 1839, p. 40.*

¹⁰ *Mém. de la Soc. de Chir. de Paris, t. i.*

¹¹ *Dict. de Méd., t. xxix, p. 570.*

¹² *Compend. de Chir. Pratique, t. ii, p. 591.*

¹³ *Trans. Path. Soc., 1854, vol. vi, p. 25.*

to his death, and it saturated the pillow-case, but, although repeatedly collected, does not appear to have been analysed chemically. At the necropsy there was a fracture of the occipital bone on the right side with some communication, and another to the left of the foramen magnum, extending from that to the back part of the left jugular foramen. The tube of arachnoid membrane which accompanied the seventh pair was quite normal, but a minute quantity of blood was found in the subarachnoid tissue surrounding the nerves. The cavity of the tympanum was full of a thick, tenacious, muco-purulent secretion, and a similar secretion was found at the tympanic orifice of the Eustachian tube and also in the mastoid cells. The lining membrane of the tympanum and parts communicating was intensely vascular. The membrana tympani was ruptured.

Mr. Holmes's patient was also an inmate of St. George's Hospital. He was admitted with bleeding from the ear, which was followed by a copious watery discharge. When examined after death, the most careful search discovered no fracture in the petrous bone, and no injury of any kind to the cavity of the tympanum or internal ear. The discharge was dependent upon fracture of the lower jaw just below the condyle, the lower fragment having perforated the wall of the meatus auditorius.

In the former case the fluid appeared to have been derived from the mucous lining of the middle ear and its accessory cavities, and in the latter from the wounded meatus, possibly, also, from the lining membrane of the articulation of the jaw.

Although there are many statements with regard to fractures in the temporal bone made by Dr. Buck in his article on Injuries and Diseases of the Ear, in the *International Encyclopedia of Surgery*,¹⁴ with which I cannot agree, there is one which is to me a very good suggestion with regard to some of these watery discharges. Speaking of fracture with laceration of mucous membrane in the ear and rupture of the membrana tympani, he says: "Such a laceration of the parts is sure to be followed by inflammation; and this inflammation will be proportionate to the degree of damage done to the parts. A profuse and sometimes long-continued watery discharge from the middle ear, by way of the external auditory canal, is a well-known characteristic of an ordinary, non-traumatic, acute inflammation of the middle ear, provided that an opening has been established, either by natural or by artificial means, in the membrana tympani," etc.

In many instances it passed out in large quantities, so as to permit of examination. When free from discoloration by blood, the watery discharge will be found to have the same limpid, clear appearance as the cerebro-spinal fluid, but occasionally has a higher specific gravity (in one case it was 1013), abundance of chlorides, a very small amount of albumen, as indicated by the usual tests—merely enough to produce a whitish opacity—and a trace of some substance which for a long time was regarded as sugar, but which Dr. Halliburton identifies with pyrocatechin. This substance reduces Fehling's solution, but does not answer to some other tests for sugar. The flow may be accelerated, as Hilton proved, by increase of the intracranial vascular pressure, produced by compression of the jugular veins whilst the nose and mouth are covered; and it may be increased by coughing or other strain, as in patients who were under observation in St. Thomas's Hospital.

The quantity of this fluid that may be collected is occasionally very large, sometimes running from the ear in a continuous stream; it saturates the pillow and the bed-clothing. In the following case, during the course of five hours, this amounted to three pints; and, as the flow continued for ten days without ceasing, the quantity which came away during that time was, indeed, enormous. The symptoms which ensued when the excessive loss at last stopped are interesting, as well as the almost complete absence throughout of serious mental disturbance.

A carpenter, aged 25, came under the care of Sir W. Mac Cormac¹⁵ on July 2nd, 1885. A short time before he had been knocked down by a plank, which had fallen on the back of his head, and had rendered him insensible for ten minutes. He bled profusely from the right ear. On admission not long afterwards there was a red mark on the back of the head where he had been struck. He was quite conscious, complaining only of headache. There was a very considerable discharge from the right ear, of a watery fluid tinged with blood. His temperature was 98.8°. He had severe vomiting, which only ceased on the following morning. Next day the temperature in the morning was 98.8° and in the evening 101.8°. The dis-

charge from the ear continued profusely, and the flow was markedly accelerated by any straining. On the third day he complained of a splitting headache. His tongue was furred and white, and the temperature rose from 101.4° at 2 A.M. to 104° at 8 P.M. On the fifth day the discharge from the ear was continuing to such an extent that the pillow became saturated, and during a period of two hours and a half no less than one pint and a half of this fluid (having a greenish tinge and giving the chemical reactions of cerebro-spinal fluid) was collected. On the sixth day the headache, which was chiefly occipital, had become slight. He was much improved and quite intelligent. The fluid was flowing less freely; it was clear and limpid. Deafness was noticed; he could only hear a watch on contact. On the ninth day he could sleep without a draught of chloral, but the discharge from the ear only ceased in the afternoon of the eleventh day, the temperature being as high as 103° in the evening. He was not so well after the discharge ceased; there was much headache and pain in the back of the neck and flushing of the face. The headache was very severe, making him cry out with pain. He became delirious and noisy. The pupils continued equal, and acted well to light. He continued ill for two days, then improved, the headache ceasing except when he moved; any sudden movement immediately brought it on again. The day after the cessation of the discharge from the ear the ophthalmoscope revealed a peculiar rosy appearance of the fundus oculi on both sides, without evident dilatation of vessels. After this he only complained of dizziness for a few days when he bent forwards. The man was under observation for fifty-five days, and no further symptoms developed.

Sir Prescott Hewett,¹⁶ who has done much for the surgery of this part of the body, divides these cases into three classes: 1. When the fluid from the ear is plentiful and of a decidedly watery character immediately after the accident, this flow is due to the escape of cerebro-spinal fluid, as a consequence of fracture of the petrous bone implicating the internal auditory canal and its membranes. Three cases amongst those which proved fatal came under this heading; in two the fracture extended into the internal auditory meatus, and during life was accompanied with evidence of facial paralysis on that side. In a third case the fracture extended across the meatus internus.

2. When the watery discharge from the ear is preceded by copious and prolonged hæmorrhage, a fracture of the petrous bone may be safely diagnosed, but it cannot be said that the fracture follows any particular course. Five of the fatal cases presented this sequence of the discharge, and in all there was a fracture of the petrous bone; in one the internal auditory meatus was involved, and the facial nerve torn.

3. When there is a discharge of blood only, neither copious nor prolonged, which is followed by a watery discharge, varying as to the time of its appearance, varying as to its quantity. It may be present within a few hours after the accident, it may be profuse within a few hours after its appearance. These are the cases in which it has been proved that the diagnosis is doubtful. The fact that too much reliance should not be placed on this symptom is illustrated by the case of one patient, a child of 3½ years, who was under observation. The discharge followed slight hæmorrhage from the left ear, and continued for two days in no great quantity. After death, which occurred on the third day following the injury, although there was a fracture in each fossa of the base, including the middle fossa on the left side, it did not involve any part of the auditory apparatus.

I am of opinion that more reliance should be placed on chemical analysis of watery discharges from the head. If these show on examination the presence of a large amount of chlorides, and give the sugar reaction to Fehling's solution, then we may say that there is a fracture and communication with the subarachnoid space through a tear in the tubular prolongation of the membranes which surrounds the facial and auditory nerves; and this applies although there be some albumen from admixture with serum, blood, or secretion from the ear. Sometimes, however, the watery discharge is not in quantity sufficient to permit of its being collected and of our applying the usual tests to it. We must then, I think, be guided by the amount of the hæmorrhage as to the presence of fracture, and the onset of facial paralysis or deafness, dating only from the injury, as to its extension into the internal auditorius meatus and subarachnoid space.

An interesting feature of the injury to the head which was sustained by Emin Pacha during last year, as reported in the daily press, was the recurrence of a watery discharge after it had

¹⁴ Vol. v. p. 351.

¹⁵ *Lancet*, 1886, vol. ii, p. 211.

¹⁶ *Loc. cit.*

ceased for a time. This was noted in two patients who were in St. Thomas's Hospital. A man, aged 45, was admitted unconscious, with a tolerably large quantity of blood flowing from the left ear. Slight watery discharge followed, which, however, ceased in a day or two. He suffered from signs of serious cerebral injury, but had no further discharge from the ear until the eighteenth day, when a yellowish clear fluid commenced, and continued to flow for seven days.

A man, aged 64, was admitted with hæmorrhage from the left ear, followed by a thin discharge for two days; it recommenced on the sixth and continued till the eleventh day.

A case somewhat resembling the one which I have read, in which there was an excessive flow of fluid from the ear, which also illustrates the recurrence of the watery discharge has been recorded by Dr. Campbell. The patient died comatose on the fourth day after the return of the discharge. The fracture had passed through the internal auditory canal, but there was no evident cause for the fatal coma.

Sir William Savory had a patient under his care in 1861, who had watery discharge from both ears which lasted for nearly a month. The patient, a boy aged 13, recovered.

Sometimes the flow of either blood or watery fluid from the ear will be observed to pulsate; occasionally small air bubbles are seen in it.

As regards the influence of age in the occurrence of these watery discharges, it appears from a consideration of those cases from which my statistics are taken, that if all in whom watery discharges of every kind occurred are included, of those surviving thirteen were below and fourteen above 30 years of age. Of those in whom the injury proved fatal, five were below, and four above that age; this average corresponding fairly with the ratio of fracture at the various ages of life.

Age, years ...	5	10	20	30	40	50	60	70
Recovered ...	0	2	4	7	7	4	2	1
Died ...	2	0	0	3	2	1	0	1

That is to say, that out of thirty-six cases presenting this phenomenon, one-fourth died, although in none of the nine fatal cases could it be said that death ensued in consequence of the opening up of the subarachnoid space, yet in one the fracture of the petrous bone gave opportunity for purulent infection of the meninges, which caused death. Robert looked upon this symptom as of extremely bad augury, indeed he writes of it as follows: "Up to the present, in fact, one has not been able to save any of those who have presented this symptom." The seven cases under his observation died, and he cites another under the care of Marjolin. Colles, in his lectures, says that he has seen such cases recover; but regarded them as mostly fatal.

The idea suggests itself that perhaps the changed conditions under which such cases come nowadays when admitted to our hospitals and infirmaries may have much to do with the better prognosis now given in these injuries, which are accompanied by watery discharges from the ear—the greater care which is taken in cleansing, not only the patients but also the wards, the employment of efficient ventilation, and the use of antiseptics. The rare occurrence of suppuration in wounds, the almost complete banishment of pyæmia and erysipelas, or the transfer of the latter to a special ward should it unfortunately arise, are things which must be taken into consideration. But in spite of these improvements in the surroundings of our patients suppuration occasionally follows hæmorrhage or watery discharge, and the prognosis becomes correspondingly increased in gravity.

Another source of infection, and a most dangerous condition for the patient, is the presence of otitis media of old standing, or the existence of some purulent discharge from the ear before the injury to the head, whether that injury be followed by simple hæmorrhage or by hæmorrhage and then a watery discharge. Of two cases, in the first there were many symptoms present which make it of interest beyond the occurrence of purulent discharge from the ears, and several of the more distant fractures supplicated, probably in consequence of the extremely low condition of health of the boy and the vital depression following such an extensive and severe injury to the head, and not from pyæmic infection.

The attention of the profession was first drawn to the fact that watery discharges occasionally come from the nose after head injuries by Blandin, who reported a case in 1840, that of a man, aged 32, who had shot himself with a medium-sized pistol, the bullet of which lodged in the sella Turcica, destroying part of the

pituitary body. "There flowed from the nostrils a quantity of bloody serum truly enormous." M. Robert recorded another case five years afterwards, and proved the identity of the fluid with the cerebro-spinal, and the *post-mortem* examination showed a fracture of the sella Turcica, laceration of the overlying dura mater and arachnoid over the anterior lobes of the brain.

I have only met with discharge from the nose twice after severe head injury, and its importance and character were very doubtful in the first of these.

A boy, aged 13, was under the care of Mr. Sydney Jones. He was admitted on January 4th, 1882, and continued insensible for an hour and a half. The accident—a fall from a cart—had happened twenty-four hours earlier, and he was still vomiting. Hæmorrhage from the right ear continued for a day, and there was a yellowish white discharge from the right nostril, which continued when he was removed by his parents five days later.

In the second it is possible that there was a fracture of the petrous bone, implicating the internal auditory canal, but without rupture of the membrana tympani. The character of the fluid, the deafness, and noises in the ears point to this explanation.

A man, aged 25, admitted on December 7th, 1886, under the same surgeon, having fallen 14 feet on his head. He was unconscious for a while, and when admitted an hour later there was a large scalp wound, and there had been epistaxis. On the next day there was subconjunctival ecchymosis of both eyes, with contusion of the eyelids. On the fourth and fifth days he complained of noises in the left ear, and on the sixth it was noticed that there was a discharge of a few drops of clear watery fluid from the left nostril. Some of this was collected; it was clear with a yellowish tinge, slightly alkaline reaction, a trace of albumen, and marked proportion of chlorides. On the eighth day he had had a good deal of headache during the night, and on raising him up some clear fluid resembling that collected on the sixth day again ran from the nose; it was not coagulated by heat or nitric acid, contained a large proportion of chlorides, a trace of albumen, but no sugar. He was quite deaf with the left ear, even when the watch was placed against the mastoid process or the left side of the forehead. He complained of a rumbling noise, and occasionally of singing in the ear, and was deaf when dismissed after forty-four days' residence.

M. Foucard¹⁷ recorded a case in which a fracture of the base of the skull was accompanied with the flow of a watery fluid from the left nostril only, and Malgaigne¹⁸ another in which a free discharge took place from both nose and ear.

Writing on the subject of nasal discharge after injuries which had been supposed to produce fracture of the base of the skull as indicated by a discharge from the nose, M. Robert drew attention to the occasional flow of a limpid salt fluid, sometimes in considerable quantity, from the nose independent of traumatism, and mentions a patient who could fill a wineglass in the space of an hour, and saturated twenty-five to thirty handkerchiefs in the course of the day. He did not analyse the fluid.¹⁹

As I am chiefly concerned now with those fractures which involve the base of the skull, I do not purpose to consider the escape of cerebro-spinal fluid consequent on fracture of the vault. It may, however, be found under the scalp after a recent fracture of the subjacent bone, or later forming a soft compressible tumour over the site of the fracture. It flowed from the wound after a recent compound fracture of the skull, in which I found it necessary to remove fragments of bone from near the base, and in which there was a laceration of the underlying brain. It has flowed from the wound after trephining; and I have seen it coming in large quantities in cases of hernia cerebri, in which sloughing of brain substance had opened up the lateral ventricles. Several instances of traumatic cephalo-hydrocele have been shown at the Medical Societies during the last few years; but as a recent condition I have only seen it once, and that was in the case of a baby under the care of Mr. R. W. Parker at the Children's Hospital. The child presented a curious forcing outwards of the bones forming the posterior part of a fracture in the right parietal region, the result of considerable violence, and covering the fracture was a large, soft, fluctuating swelling which pulsed.

Protrusion of the brain substance after an injury to the head which has caused a fracture of the base of the skull is an occur-

¹⁷ *Journal de Chir. de Malgaigne*, 1846, p. 315.

¹⁸ *Ibid.*, p. 283.

¹⁹ See also the observations of Brodie and Sir James Paget.

rence of very great rarity; in only one of the 54 cases of fatal injury is it recorded, and then it was through a fracture of the middle fossa. Indicating as it does a most severe injury to the base as well as to the brain, it is not surprising that such cases have usually had a fatal ending. There are, however, instances on record in which its escape from the ear or from the nose has been observed, and yet recovery, apparently complete in every respect, has ensued. I find an account given of the occurrence of the latter not followed by a fatal issue reported by Mr. Luther Holden—a compound fracture of the skull in a man of 40, in whom there was an escape of cerebral matter from the wound and through the nostril. The fracture, extending over the margin of the orbit, had involved the frontal sinus and thus allowed the escape of a portion of the brain through the right nostril on the day following the injury. Dr. Lockwood²⁰ reported a case in which a loss of cerebral substance from the ear followed a fall on deck. The patient recovered.

THE CROONIAN LECTURES ON CEREBRAL LOCALISATION.

Delivered before the Royal College of Physicians of London.

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LECTURE V.

MR. PRESIDENT AND GENTLEMEN.—Followed upwards in their course to the brain, clinical and pathological investigation would appear to show that in the medulla and pons the sensory tracts run in the fillet, or formatio reticularis. Those tracts—namely, the posterior external and posterior median—which do not decussate in the cord, decussate through the nuclei graciles and cuneati into the inter-olivary layer, and thence into the fillet and reticular formation (Edinger). Higher up, the evidence is in favour of the continuation of these tracts in the tegmentum of the crus cerebri, and thence into the posterior part of the internal capsule, whence they radiate outwards, according to Flechsig, and distribute themselves to the cortex in the region lying between the fissure of Rolando and the occipital lobe. It has been supposed by Meynert that the outer third of the foot of the crus is the path by which the sensory tracts of the spinal cord pass into the internal capsule; and in favour of this view is the fact that descending degeneration, while frequently found in the other fibres of the foot of the crus, has not usually been found here. Bechterew and Rossolymo,¹ however, have reported cases of degeneration of this part of the crus apparently in relation with lesion of the temporal and occipital lobes, and it is held by Flechsig that these fibres do not enter the internal capsule, but bend downwards and outwards to radiate in the cortex of the occipital and temporal regions. They are supposed to connect these regions with the cerebellum through the intermediation of the grey matter of the pons, but this is a point which, I think, stands in need of further investigation. In order, if possible, to throw light on the functions and connections of this part of the crus, I have recently divided it in three monkeys. The operation is a somewhat severe one, but the crus can be comparatively easily exposed to view after removal of the lower portion of the temporal region. In all three animals the lesion was satisfactorily established, but none of them recovered sufficiently from the operation to enable me to make altogether reliable observations. But in none of them was there total loss of reaction to sensory stimulation, or greater impairment than could be accounted for by the cerebral lesion. So far as they go, therefore, the experiments are opposed to the view that the outer third of the foot of the crus is the path of the sensory fibres from below.

That the sensory tracts lie distinct from the motor in the posterior division (or rather posterior third of the posterior segment) of the internal capsule has been amply proved by the experiments of Veyssièr² and by the researches of Charcot, etc., on cerebral

hemianæsthesia occurring in man. The sensory tracts being admittedly distinct from the motor in the internal capsule, the question then arises whether these, which up to this point have maintained their separate position, fuse in the cortex with the motor, —as some believe—or are distributed to a special region.

In my earlier researches I had observed that tactile and common sensibility appeared to be entirely unaffected, notwithstanding the most extensive lesions of every portion of the convex aspect of the hemisphere, but I noted in several instances in which the destructive lesions extended deeply into the temporal lobe that sensibility became impaired or abolished on the opposite side of the body. Careful *post-mortem* examination showed that in all these cases the hippocampal region (including cornu ammonis and gyrus hippocampi) was more or less extensively invaded. These facts pointed to the hippocampal region as being the centre of common sensibility, and I therefore devised experiments by which I might reach and destroy this region by itself. On account of its deep-seated and concealed position this is, however, practically impossible, and it therefore can only be reached by methods which involve a greater or less extent of injury to the occipital lobe, or the lower temporal region. The effects of lesions of these regions can, however, be allowed for and eliminated, and any further symptoms than can be ascribed to them can be connected with those inflicted on the hippocampal region. The method which I followed in my earlier experiments was to break up and destroy the hippocampal region by means of a wire cautery thrust through the occipital lobe, and directed downwards and forwards in the course of the descending cornu of the lateral ventricle. In this manner I succeeded primarily or secondarily in entirely destroying the hippocampal region and its medullary connections without inflicting injury on the crus cerebri or neighbouring structures. The diagram before you³ is an accurate representation of the superficial appearance of the lesion in one of these cases, and the track of the sinus made by the cautery. The result of this operation was anæsthesia and analgesia of the opposite side of the body, there being total or almost total absence of response to any kind of sensory stimulation. The limbs were not paralysed as to motion, but they appeared to be used with difficulty and awkwardness, and the feet tended constantly to slip off the perch when the animal shut its eyes and went to sleep. In none of my earlier experiments were the animals allowed to live for any length of time, as I considered it necessary to kill them as soon as the symptoms were clearly defined in order to avoid complication by secondary extension of the lesion, antiseptic surgery not being at this time in vogue. The lesion in this case was shown⁴ to be strictly limited to the hippocampal and occipito-temporal region, and without any implication whatever of the internal capsule or crus cerebri. These experiments did not furnish any data towards the determination of the permanency of the symptoms, but they were sufficient to indicate a region, if not the whole region, related to the tactile, common, and apparently the so-called muscular, sensibility of the opposite side of the body.

I renewed my investigations on this subject at a later date⁵ in conjunction with Professor G. F. Yeo. The method of performing the experiments was partly the one I had previously followed, namely, the destruction of the cautery, and partly that of cutting in towards the hippocampal region from the convex aspect of the temporo-sphenoidal lobe. Ten experiments in all were performed, and in five of these in both hemispheres. The result of this series of experiments confirmed in every particular those I had already arrived at, and showed that tactile sensibility was in every case impaired or abolished, in proportion to the destruction of the hippocampal and inferior temporal region. Unfortunately, none of the animals in which the destruction was complete, and the anæsthesia absolute, survived many days, so that the question of duration still remained unsolved. But it was established that a very extensive lesion might be made in one or both hippocampal regions without producing permanent anæsthesia. I need not enter into the details of all these experiments. The two following will suffice.

In one experiment⁶ the left hemisphere was exposed and the whole of the inferior temporal convolution and hippocampal region were severed and scooped out, the lesion being such as to leave only the internal margin of the gyrus hippocampi with the

²⁰ *American Journ. Med. Sci.*, 1859, p. 254.

¹ *Neurolog. Centralblatt*, No. 7, 1886.

² *Recherches Cliniques et Expérimentales sur l'Hémianesthésie de Cause Cérébrale* 1874.

³ See Fig. 105, *Functions of the Brain*, p. 329.

⁴ See Figs. 107 and 108, *Functions of the Brain*, p. 331.

⁵ *Phil. Trans.*, Part II, 1884, Experiments XXIV to XXXIII, Figs. 103 to 181.

⁶ Experiment XXVII, Figs. 125, 132, *op. cit.*