ANALYSIS OF THE CASES
OF
INJURIES OF THE HEAD,
EXAMINED AFTER DEATH IN ST. GEORGE'S HOSPITAL,
From January, 1841, to January, 1851,
WITH
PATHOLOGICAL AND SURGICAL OBSERVATIONS.
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Received April 13th.—Read May 24th, 1853.

Thinking that some important points of practice might be illustrated by the classification of a large number of fatal cases of Injuries of the Head, occurring in a civil hospital, I venture to lay before the Society an analysis of all those cases, which were examined after death at St. George's Hospital, during a period of ten years. In this analysis, I have purposely included only those cases which were examined; as it is in fatal cases alone that the exact nature of the injury, and its extent, can be clearly made out. The observations are confined to cases which have occurred at St. George's Hospital; and those points, the value of which has been tested, either in the wards, or in the dead-house of the hospital, have been principally dwelt upon.

The present Paper relates simply to Scalp-wounds, and to Fractures of the Skull; but it is my intention, should this communication be favorably received, to bring before the Society, at an early period, the analysis of the other injuries belonging to this subject.

SECTION I.

Scalp-wounds, without Fracture of the Bones.

In this decennium, 33 cases of scalp-wounds, without fracture of the bones, were examined. In 10 of these cases, death was produced by some other cause, there being no unhealthy appearance, either about the wounds, or the bones of the cranium. In the remaining 23 cases, mischief of a serious nature soon followed the injury, and ultimately proved fatal. In these 23 cases, the wound in 7, was on the forehead; in 7, it was at the back of the head; in 6, it was in the parietal region; in 2, it was in the temporal region; and in 1, it was on the crown of the head. In 8 cases, the wound was large, extending, in 2 cases, the whole length of the skull, from the front to the back part; in 9, the wound was contused; in 7, the surface of the pericranium alone was exposed; and, in the remaining 16, the bone was either laid bare at the time of the accident, or became so shortly afterwards.

Diffuse cellular inflammation occurred in 17 cases, and in 12, this was accompanied by erysipelas. This inflammation presented itself under the occipito-frontalis muscle, in the shape of simple œdema, of lymph and pus, or of suppuration and sloughing, undermining, and, in one instance, completely separating the scalp from the parts below. In 4 cases, there was also diffuse inflammation of the neck, which spread down to the mediastina in 2 cases, and it was accompanied by œdema of the larynx in 2. The diffuse inflammation, running on to sloughing, was in 2 cases followed by hæmorrhage, which in 1 was of a very severe character.

In 12 cases, no traces whatsoever of inflammation were found, either in the membranes or in the brain; of these, the diffuse inflammation proved fatal in 3; and in the other 9, death was caused by purulent infection: in addition to the injury of the head, there was in 1 of these simple fracture of the internal malleolus, and in 1 there was fracture of several ribs.

In 10 of the remaining 11 cases, inflammation existed about the membranes or the brain, in 8 of which suppuration, more or less extensive, was found between the bone and the dura-mater; 5 of these were complicated with purulent infection. In addition to the injury of the head, there was also in 1, compound fracture of the leg; and in 1, fracture of the spine, but this was not accompanied by any symptoms.

In 1 case, sloughing of the dura-mater, without any injury to the internal part of the bone, had taken place opposite to a large abscess, which originally had begun in the structure of the brain.

In all these cases, the bone was exposed; in 4, the exposed bone was discoloured, being of a dark, or of a yellow tinge; in 5, matter was detected in the diploë. The trephine had been applied in 3 of the cases of suppuration between the bone and the dura-mater, as well as in that of the abscess of the brain.

These 23 patients were, for the most part, persons of dissolute habits, and many were addicted to hard drinking. Several of them had insisted on leaving the hospital, but were readmitted on account of the diffuse inflammation which had subsequently made its appearance.

The diffuse inflammation proved fatal in 3 cases: in 1 patient, *æt.* 32, the inflammation was confined to the soft parts about the skull,—he lived seven days: in 1, *æt.* 65, who lived nine days, the inflammation was very extensive, and accompanied by erysipelas, which spread over the face: in the third case, there was also diffuse inflammation of the neck, spreading down to the mediastina, with œdema of the chordæ vocales; the patient, *æt.* 65, lived eight days.

In hospital practice, an injury of the scalp, even of a slight nature, is not unfrequently followed by an œdematous swelling, which may spread over the whole scalp, and in such cases, simple acupunctures, if made at an early period, and repeated according to circumstances, as pointed out by Sir B. Brodie, are generally sufficient to prevent any further mischief. Should the inflammation run on to the effusion

of lymph or pus, then free incisions become necessary. Sometimes, notwithstanding these free incisions, now commonly made in diffuse inflammation of the scalp, the cellular tissue sloughs; but, generally, if this treatment has been carried out at an early period of the attack, and to the necessary extent, the skin may be saved. In a few cases, the sloughing process may extend over the whole surface of the skull, from the front to the back part, and, after the separation of the sloughs, the over-distended and perfectly loose scalp, presenting a puckered and baggy appearance, looks by far too large for the cranium, so large that it might be thought impossible for the parts ever to regain their natural size; and yet, after a time, the skin is observed to be less and less flaccid, and ultimately it readapts itself most perfectly. Should the skin and the pericranium, fortunately a very uncommon occurrence in the present day, also become involved in the sloughing process, the bones of the skull may become exposed to a very great extent. A middle-aged woman, who was admitted into St. George's Hospital, under the late Mr. Walker, with a burn occupying the neck, and other parts of the body, was attacked with diffuse inflammation of the scalp, which, notwithstanding the incisions which were made, ended in extensive sloughing of the skin, with separation of the pericranium, and denudation of the bone, involving the frontal, both parietals, and a large part of the occipital, after which the patient lived some time, and ultimately died exhausted.

This sloughing may be followed by hæmorrhage, sometimes of a serious nature, the source of which may be a matter of great uncertainty. Should the sloughing be confined to one part, the source of the bleeding may be easily ascertained; but, should the bleeding occur in one of those cases where the whole scalp has become detached, it will lead to great doubt and perplexity. Being in the wards of the hospital, I was once sent for to a patient suffering from a sharp attack of hæmorrhage, in whom the whole scalp had been detached by extensive sloughing of the cellular tissue, following diffuse inflammation. I found the scalp, previously

loose and baggy, now stretched, and made tense by a large accumulation of blood under it, the more fluid part of which was pouring out in various directions through several large incisions made some days previously. It was evident that this hæmorrhage was proceeding from some large vessel, but it was difficult to say whether it came from either of the temporal arteries, or even the occipital arteries. Having established pressure on the trunks of these four vessels the blood was pressed from under the scalp; the pressure was then taken off from the vessels one by one, and the bleeding was found to arise from one of the occipitals, or some of its large branches. As pressure controlled the hæmorrhage, a pledget of lint was applied over the artery, low down on the occipital bone, and firmly fixed there; this had the desired effect, and no more bleeding occurred.

Separation of the dura-mater from the bone may occur either as a primary, or as a secondary effect. In the first, the small vessels connecting the dura-mater to the bone are ruptured by the blow, and the membrane is in consequence detached from the bone to a greater or less extent. In the second, the osseous tissue itself inflames and suppurates, either in consequence of the contusion of its diploë, or in consequence of the bone being deprived of its periosteum.

Generally speaking, the suppuration between the bone and the dura-mater is circumscribed, and the extent of the mischief on the inner side of the bone is exactly traced by that on the outer side; but, should the suppuration occur in the parietal region, the mischief may be of a much more diffuse character, and that too without any evidence of its extent on the external parts. Occurring in the parietal region, the matter may follow the course of the branches of the middle meningeal artery, and running along the cellular tissue surrounding these vessels, it may reach the base of the skull, and extend as far as the foramen spinosum. Of the eight cases of suppuration between the bone and the dura-mater, observed in these ten years, three presented this form of the disease.

In this decennium, there has been no single instance, nor

indeed do I ever recollect having seen one, of the secondary puffy tumour of the scalp, described by Pott and others, as indicative of mischief between the bone and the dura-mater.

Suppuration between the bone and the dura-mater appears not only to have been much more frequent, but also very much more commonly confined altogether to this situation formerly than it is in the present day.

In the second section of 'Injuries of the Head,' Pott gives twelve cases of scalp-wound followed by subsequent mischief beneath the bone, in seven of which the suppuration was altogether confined to the outer surface of the dura-mater. In the various cases which I have noticed of this affection, I have never seen a single instance in which the suppurative inflammation was thus limited; in every case which I have examined, inflammation has at the same time existed beneath the dura-mater. It cannot be said that this very marked difference depends upon the amount of inflammation, or the quantity of matter thrown out, for in several of Pott's cases not only was the quantity of matter thus situated very large, so large indeed that it was thought impossible for the patients to recover, but the inflammatory process had been going on for some days, as shown by the symptoms and the quantity of matter evacuated from the spot where the trephine was applied; whereas, in several of the cases which I have noticed, although the extent of the mischief between the bone and the dura-mater has been comparatively trifling, still the diffuse inflammation beneath the membrane has been most extensive. In every one of the eight cases of suppuration between the bone and the dura-mater occurring in this decennium, puriform effusion was found within the cavity of the arachnoid, and appeared to have spread from the external to the internal parts. That this difference does not depend upon locality is evinced by the results of similar cases in different places and in different countries.

Suppuration between the bone and the dura-mater naturally leads to a practical question of the utmost importance, I mean the application of the trephine. Formerly,

and especially in Pott's hands, it appears in such cases to have been one of the most successful operations. Mischief was suspected under the bone, the trephine was applied, matter was found, in some cases in large quantities, and evacuated, and the patients recovered without any further difficulty. Such is the history of several of Pott's cases; but, unfortunately, we have met with no such success. It has never yet fallen to my lot to see a single instance in which the application of the trephine has, under such circumstances, had a successful issue. In every case in which I have seen the operation performed, the patient, notwithstanding the evacuation of the matter, has died of diffuse inflammation of the membranes. Still, notwithstanding that our efforts have been so unsuccessful, we do not hesitate, whenever the various symptoms lead to the diagnosis of matter between the bone and the dura-mater, to apply the trephine, and we give the patient the only chance, however small that may be, of recovery; but, on the other hand, we consider the application of the trephine altogether useless in cases of intra-cranial suppuration, where the symptoms are those of acute inflammation of a diffuse kind, in which the signs of compression are generally but slightly marked.

Of the eight cases of suppuration between the bone and the dura-mater without fracture, noted in this decennium, five were not operated upon, and three were trephined. In the first class, in which no operation was performed, the symptoms of compression were either but very slightly marked, or altogether absent.

A man, æt. 20, was admitted into St. George's Hospital, under the care of Mr. Cutler, in July 1845, with concussion of the brain, and a small scalp-wound, exposing the right parietal bone. He went on well for a fortnight, but symptoms of inflammation of the membranes then began to show themselves; he was bled, and put upon mercury, but the symptoms became more marked, and profuse perspirations and severe rigors soon made their appearance; he

lived twenty-nine days after the accident, there never having been any symptom of compression, save a slight drooping of the right eyelid. On removing the skull cap a small quantity of lymph and pus was found under the exposed bone, which itself was of a dark yellow colour; from this point lymph and puriform fluid were traced along the cellular tissue of the branches of the middle meningeal artery to the base of the skull, where suppuration also existed around the various foramina of the sphenoid, as well as in both orbits. In all these parts, the dura-mater was most readily detached from the bone. There was also extensive effusion in the cavity of the arachnoid, and in the sub-arachnoidean tissues, with inflammation of the brain. Both lungs presented marks of purulent infection. The other viscera were healthy, excepting the kidneys, which were mottled.

A man, æt. 50, who was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, with an extensive and bruised wound of the scalp, not exposing the bone, was attacked with diffuse inflammation and sloughing, which ended in exposure of the parietal bones to some extent; he was apparently recovering from this attack when severe symptoms of diffuse inflammation of the membranes made their appearance. Two days before his death he had a rigor, which was followed by spasm of the right arm, then paralysis of the right leg, and at last he became perfectly insensible. He lived eighteen days; the most prominent and earliest symptoms having been those of inflammation of the membranes of a diffuse character. The skull cap having been removed, nothing was observed under the exposed part of the right parietal, but a small quantity of pus was found immediately under the exposed part of the left parietal, the diploë of which was extensively infiltrated with matter; pus was also traced some distance along the middle meningeal artery, and in the structure of the dura mater. Large quantities of lymph were found both in the cavity of the arachnoid and in the sub-arachnoidean tissues,

but the effusion was principally confined to the upper surface of the left hemisphere. Some puriform fluid existed in the superior longitudinal sinus.

A man, æt. 30, who was admitted into St. George's Hospital, under the care of Mr. Tatum, with a large scalp-wound, exposing a portion of the left parietal, was attacked with diffuse inflammation of the scalp, and symptoms of inflammation of the membranes; he lived sixteen days, during which time he never had any symptoms of paralysis. Immediately under the denuded bone there was a small quantity of pus; puriform effusion was also traced in the cellular tissue, along the course of the middle meningeal artery, and in the dura-mater. The cavity of the arachnoid and the sub-arachnoidean tissues, on the left side, were filled with lymph and pus: the corresponding portion of the brain was inflamed.

A man, æt 60, was admitted into St. George's Hospital, under the care of Mr. Tatum, in June, 1847, for a large scalp-wound not exposing the bone; he went on well for seven days, when diffuse inflammation made its appearance about the scalp; sloughing of the cellular tissue ensued, and the bone became exposed. He recovered from this attack, and progressed favorably for some time, when he was seized with inflammation of the membranes of the brain. He lived five weeks, and never had any signs of compression. Under the exposed bone, which was of the size of a shilling, was a small quantity of purulent lymph on the dura-mater; the bone itself was discoloured throughout and dark; large quantities of sero-purulent fluid, with a thick coating of lymph, were found both in the cavity of the arachnoid and in the sub-arachnoidean tissues; the brain was inflamed; lymph and pus existed in the superior longitudinal sinus, and the right lung was affected with purulent infection.

A very stout, middle-aged man was admitted into St. George's Hospital, under the care of the late Mr. Walker,

in November, 1842, with a scalp-wound in the right temple, laying bare the bone; diffuse inflammation of the scalp having supervened, incisions were made, but a portion of the occipital subsequently became exposed; he lived one month. Under the exposed bone, in the right temple, which was of a scabrous appearance, the dura-mater was inflamed, thickened, and partially separated; and, exactly limited to this spot, there was an effusion of lymph and pus on the parietal layer of the arachnoid, but all the other parts of the membranes and of the brain were quite healthy. Nothing was observed under the exposed portion of the occipital. There was recent effusion in the right pleura, with secondary deposits in both lungs.

Whenever I have seen the trephine applied at St. George's Hospital, for intra-cranial suppuration, in addition to other symptoms, those of compression have been among the most prominent, and the operation was performed under the supposition that the matter would be found between the bone and the dura-mater.

A lad, æt. 16, was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, in August, 1843, with slight concussion of the brain, and a small scalp-wound exposing the bone, which had been caused by a fall from a horse. He went on well for nine days, when he was attacked with feverish symptoms and pain in the head, which were relieved by bleeding and purgatives. On the twelfth day, there was vomiting, with a rigor and profuse perspiration, but there was no pain in the head; on the thirteenth day, the wound presented an unhealthy appearance, the bone was quite dry, the right eye-lid drooped, and the pupil was sluggish, and there was loss of power on the left side, but sensation still remained. One crown of a trephine was applied over the denuded bone, and a small quantity of matter was evacuated from between the bone and the dura-mater; some matter also appeared to come from the diploë itself. The relief was but partial, and the

patient died comatose on the following day. The diploë of the frontal bone, in the neighbourhood of the spot where the trephine had been applied, was infiltrated with pus and very offensive. The dura-mater was separated from the bone to the extent of the size of a shilling, and the cavity from which the matter had been evacuated was strictly limited to this spot. There was extensive effusion of puriform fluid in the cavity of the arachnoid, and in the sub-arachnoid tissues; the corresponding portions of the brain were of a slate colour, soft and pulpy. The lungs and the liver were quite healthy.

A man, æt. 45, was admitted into St. George's Hospital, under the care of Mr. Keate, in May, 1845, with a large scalp-wound, extending nearly the whole length of the right side of the head, and partially exposing the bone. Everything went on favorably for thirteen days, but the wound then put on an unhealthy aspect, and the patient appeared drowsy; he made no complaint, however, and the pulse was natural. On the seventeenth day, there was a slight rigor, which was thought to depend upon some matter confined to the scalp; this was let out, but, on the following day, there was a fit, accompanied by another rigor, and the right side of the body became paralysed; there was also occasional wandering, and at other times the mind was apparently not affected. Two portions of the parietal appearing of a dark green colour, the trephine was applied over them; some yellow lymph was found on the surface of the dura-mater, and the bone itself evidently contained matter in its diploë. The cerebral symptoms went on increasing, and the patient died on the third day after the operation. In addition to the mischief on the outer side of the dura-mater, there was extensive effusion of puriform fluid in the cavity of the arachnoid, and in the sub-arachnoid tissues. Pus was found in the diploë, and in the superior longitudinal sinus. There was also purulent infection of one lung, with pleurisy and pneumonia.

A man, æt. 25, was admitted into St. George's Hospital,

under the care of Mr. Cæsar Hawkins, in November, 1849, with slight concussion, and two large scalp-wounds, one of which exposed the bone on the vertex. The wounds were followed by erysipelas of the scalp, from which he recovered; but, on the tenth day, there was a rigor, with slight delirium and great prostration. On the twelfth day, partial paralysis of the left arm and leg supervened; this became complete on the following day, when there was also loss of power over the rectum and the bladder. The bone corresponding to the wound on the vertex was quite dry. Two crowns of a trephine were applied here, and half an ounce of fetid pus and grumous blood was evacuated. No relief followed the operation, and the patient died on the following day. In addition to the mischief between the bone and the dura-mater, there was an extensive effusion of puriform fluid in the cavity of the arachnoid on both sides, as well as in the sub-arachnoid tissues, and there was a small abscess in the substance of the brain. Pus was found in the diploë, and in the superior longitudinal sinus, and there was puriform effusion in both pleuræ, with purulent infection of both lungs. The other organs were quite healthy.

I have never known the trephine applied at St. George's Hospital with the view of evacuating matter situated either under the dura-mater or in the brain. In one case, in this decennium, matter, it is true, was let out of a large abscess in the brain, but then the operation was not undertaken with this view. It was thought, from the various symptoms, that the matter would be found immediately under the bone.

A man, æt. 25, was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, in November, 1847, with a small scalp-wound, all but healed, and a narrow sinus leading down to an exposed portion of the left parietal. He had met with the injury three weeks before his admission into the hospital, by a blow from a shovel, in a drunken riot. Notwithstanding the accident, this patient had been about

his work as usual, and had only left off on account of great pain in the head, accompanied by a rigor, which had come on the day before he was admitted into the ward. These symptoms were followed by partial paralysis of the right portio-dura, with the tongue drawn somewhat to the left side; and numbness and partial loss of power of the right arm soon supervened. Brisk purgatives were administered, and the untoward symptoms all but disappeared; they soon returned, however, with more intensity, and the right side became completely paralysed. The scalp-wound was at once enlarged, and a trephine was applied over the exposed portion of bone, this was on the eighth day after his admission; some very foul matter with brain-like substance was evacuated, and two other crowns of a trephine were applied, as the dura-mater was found to be in a sloughy state, with an opening of the size of the thumb, through which the matter escaped from the deeper parts. The relief was but temporary; the patient became perfectly insensible, notwithstanding the free discharge of the matter; the dura-mater sloughed more extensively, and the brain protruded through the opening; death took place five days after the operation. The following were the post-mortem appearances. The bones of the skull were healthy; the dura-mater was in a sloughy condition, with a large opening, through which the cerebral substance was protruding, and, in the centre of this protrusion, there was a small opening leading into a large, foul abscess, which occupied the back part of the left hemisphere, and extended down to the lateral ventricle, into which it had all but burst. The abscess was perfectly circumscribed, but the surrounding parts of the brain were soft and pulpy, and of a pale lemon colour; these appearances extended nearly over the whole of the left hemisphere. The septum lucidum was softened, and easily torn, and the lateral ventricles were distended with clear serum. The cavities of both pleuræ contained bloody serum, and there was congestion of both lungs. The other viscera were healthy.

Sometimes, when the trephine is applied over a piece of

exposed and discoloured bone, it happens that matter is observed to proceed from the cut surface of the bone, before the dura-mater has been reached. The quantity of matter, under such circumstances, may be sufficient to flow up, and may lead to the supposition that the skull has been perforated long before it has been so. Lately, I witnessed a well-marked example of this; and, after the removal of the circle of bone, I distinctly traced the matter pouring out of several large holes, which proved to be the openings of the large venous channels contained in the diploë.

Purulent infection was observed in 14 out of the 23 fatal cases of scalp-wound, and, although developed in other injuries, in none is it more frequently so than in those of the head, and that, too, in cases where the injury has apparently been of a trivial nature. The well-known fact that this disease is found especially in injuries involving the osseous system, will serve to explain the frequency of the development of this most formidable complication in accidents about the head, where the bones are not only abundantly supplied with cancellous tissue, but where are also found venous canals much larger and much more numerous than in any other part of the skeleton. That no cases of this kind should have fallen under Pott's notice is surprising, and the more so, as Desault and others were at about the same period directing the attention of surgeons to this affection, as one of the most common consequences of injuries of the head.

It has been thought by some foreign pathologists, that the early application of the trephine made by Pott and other surgeons, in cases of exposed and contused bone, might, in some measure, serve to explain why these practitioners had not met with more cases of purulent infection in injuries of the head. M. Chassaignac especially thinks, that the removal by the trephine of the contused bone before supuration has taken place in its diploë, destroys the source from whence the secondary mischief is for the most part derived; but such an explanation can scarcely be admitted as a valid one; for in how many cases of purulent infection

after amputation do we not find extensive suppuration in the cancellous tissue of the bone?—cases in which there had been no injury, and in which suppurative inflammation did not exist in the bone previous to the removal of the limb.

SECTION II.

Fractures and Separation of the Sutures.

In this decennial period, 78 cases of fracture of the skull were examined; 18 of which were complicated, with other severe injuries, which, in most instances, would of themselves have been sufficient to cause death.

Of these 78 cases, 56 were simple fractures, and 22 were compound: of the simple fractures, 19 were, moreover, accompanied by wounds of the scalp, not exposing the bone.

Extensive separation of the sutures coexisted with the fractures in 14 cases.

In 47 cases, the injury had been produced by the patients having fallen from various heights; in 10, the blow on the head had been inflicted by some heavy instrument; in 4, the injury had been caused by a cart-wheel passing over the head; in 3, a sharp instrument had penetrated through the bones of the skull; and in 15, in which the injury to the bones was very extensive, no accurate account of the nature of the accident was given.

In the 56 cases of simple fracture of the skull, there was only one single instance in which the injury was confined to the spot upon which the blow had been struck, the upper part of the skull. In this case a piece of bone, somewhat larger than a sixpence, and comminuted, was driven in below the level of the surrounding parts, which presented no other traces of injury. The patient, a man forty years of age, having been thrown from his coach-box, had struck his head against the ground, and remained in a state of insensibility for some little time; having rallied, he went about his work as usual, and the fracture was not detected until some months afterwards, when symptoms of cerebral irritation made their appearance.

In the 22 cases of compound fracture of the skull, it was found, on the other hand, that the injury to the bones was in 9 cases strictly limited to the original seat of the injury. Of these 9 cases, 1 was a mere fissure; 5 were accompanied by depression; and 3 were caused by a sharp instrument. Two of the latter cases presented a somewhat unusual appearance; a small piece of bone having been partially detached was bent upwards, and thus raised two or three lines above the level of the skull; the fragment was, however, immovable, as it was still connected at one part to the surrounding bone, the external table of which was at this part only partially fractured: in one instance, the injury had been produced by a chisel falling from a great height on the head; in the other, the patient had fallen from a great height, with his head upon some iron railings, one of the spikes of which had penetrated through the bones.

Fractures of the base of the skull seldom exist alone; in a very large proportion of cases this injury coexists with fractures radiating from the point where the blow was struck. In 68 cases of fracture of the base, 6 only were confined to this region; and even of these, it was only in 2 cases that no traces of fracture could be detected at the seat of the blow. In a man, twenty-three years of age, with two bruised scalp-wounds, denuding the bone at the vertex, the left orbital plate was the only part where a fracture existed; it was a mere fissure, and no blood was extravasated in the neighbourhood. In the second case, a man, thirty-six years of age, whilst carrying a heavy piece of timber, fell backwards, and struck the back part of his head on the pavement, the piece of timber at the same time falling on his forehead. No fracture was detected either in the occipital, or in the perpendicular portion of the frontal, but the body of the sphenoid presented an extensive and comminuted fracture, from which linear fractures were traced in various directions; one fissure ran forwards into the cribriform plate of the æthmoid, and slightly into the left orbital plate of the frontal; another, passing outwards, reached the squamous suture; and a third passing outwards and backwards, along

the anterior surface of the petrous portion of the temporal, was traced as far as the squamous portion. In the remaining 4 cases, which were confined to the base, the patients had fallen on the back of the head, and the line of fracture, starting from the point which had been struck, passed perpendicularly into the foramen magnum.

In civil hospitals, a very large proportion of the fatal fractures of the skull exhibit more or less extensive injury of the base, radiating from the upper or lateral parts. Of the 78 fractures of the skull which died in St. George's Hospital in the space of ten years, 62 cases presented fractures commencing at the upper or lateral parts, and spreading into the base. In such cases the extent of the injury is easily accounted for, by the nature of the accident which usually befalls the patient; a fall from a great height, or a blow from some heavy instrument, is in a large majority of instances the cause of the fracture.

In 51 cases, the fracture was simply linear; and in 27, it was in some part of its course comminuted. This comminuted appearance existed for the most part at the seat of the blow in the compound fractures; but in the simple ones, it was mostly at the base.

In 6 cases of simple fracture, the injury was accompanied by depression, which in all was very slight. In 10 cases of compound fracture there was also depression of the fragments; in 1, this depression was very slight; but in the other 9, it was considerable. In 4 cases of fracture of the base, some fragments of bone had been displaced, and torn through the membranes; this displacement of bone, with laceration of the membranes, is rarely met with in fractures of the base. The following are the 4 cases in which it occurred. In a man, twenty-seven years of age, who had fallen from a scaffold thirty feet high, there was a laceration of the dura-mater, corresponding to a comminuted fracture of the upper wall of the left orbit. A man, thirty years of age, presented a comminuted fracture of the petrous portions of the temporal bones, with a laceration of the dura-mater on the anterior surface of the left petrous portion com-

municating with the tympanic cavity, and there was also a laceration of the dura-mater corresponding to the basilar portion of the sphenoid, through which a probe was readily passed into the sphenoidal sinuses and into the nostrils. In a man, twenty-nine years of age, who had fallen from a height of fourteen feet, several fragments of the æthmoid and sphenoid were driven through the membranes, and into the substance of the brain. A man, age unknown, whose head had been crushed by a cart-wheel, presented a laceration of the dura-mater, corresponding to a fracture of the basilar-bone, through which an escape from the posterior nares had taken place into the cavity of the arachnoid.

Fractures of the skull, with depression of the inner table alone, occur, I think, but very rarely. In the 78 cases of this decennium, it was met with three times, in two of which the depression was very slight, so slight that it might easily have escaped notice. The third instance, however, afforded a well-marked example of this kind of injury; the fracture of the inner table was extensive and comminuted, and the depression of the fragments was considerable, but the outer table presented only a slight trace of injury. I have never met with but one other case of this kind.

Practically, the skull may be divided into three different zones or segments; an anterior zone, formed by the frontal, the upper part of the æthmoid, and the fronto-sphenoid; a middle zone, formed by the parietals, the squamous, and the anterior surface of the petrous portions of the temporals, with the greater portion of the basi-sphenoid; and a posterior zone, which is formed by the occipital, the mastoid, and the posterior surface of the petrous portions of the temporals, with a small part of the body of the sphenoid.

Fractures of the skull, beginning at the seat of the blow, and from thence spreading into the base, are oftentimes, it will be found, limited exactly to the bones belonging to each of these three different zones. In 25 cases, where the injury was thus strictly limited, the line of fracture was in 5 cases traced from the forehead into the bones at the base of the anterior zone, and into these alone; from the parietals,

or temporals, in 14 cases, the fracture was found to pass into the corresponding bones at the base; and in 6 cases, the line of injury passed from the occipital into the posterior segment only. In the cases belonging to the anterior zone, the fracture passed perpendicularly in 3; in 1, it was oblique from side to side, and in 1, it was extensively comminuted. In the middle zone, the fracture was confined to one side in 12 cases, and in 2, it occupied both sides; in 1 of these there had been two distinct accidents, at an interval of a week, and there were two separate fractures, each limited to one side; and in the other case, the fracture was accompanied by separation of the coronal suture. In the posterior zone, the injury in 5 cases passed longitudinally, and in 1 there were several lines running in different directions. The results of this analysis certainly corroborate some of the views so ably advocated by Dr. Aran.¹

Frequently, however, no such exact limits can be assigned to the extent of the fracture, and two of the fossæ at the base may be involved at the same time: wedged in between the other two fossæ, the middle one, in such cases, either receives or transmits the injury. In these cases, the fracture generally runs obliquely from one fossa into the other, or else, coursing along the boundaries of the regions in the neighbourhood of the sutures, which may be widely separated, it passes into the fossæ. In 29 cases, where the line of fracture occupied two fossæ at the same time, it was found in 14 cases in the middle and anterior fossæ, and in 15 cases in the middle and posterior ones. Separation of the sutures not unfrequently accompanies this form of accident. In the cases belonging to the middle and anterior fossæ, the fracture was transverse, and occupied both sides in 7, with extensive separation of the coronal suture in 3; in 6 cases, the fracture passed more or less obliquely from side to side, and in 1, it was limited to one side. In those cases belonging to the middle and posterior fossæ, the fracture was transverse, and occupied both sides in 6 cases, in 5 of which it was accompanied by separation of the lambdoid suture, and in 1 by separation

¹ Archives Générales de Médecine, 4e série, t. vi.

of the sagittal suture ; in 4 cases the injury passed obliquely from one side to the other, and in 5, it was confined to one side.

Much less frequently does it happen that all three fossæ at the base are fractured together, and, as might be supposed, it generally only happens in those cases where the patients have either fallen from a very great height, or where the blow has been of a very severe character. All three fossæ were implicated at the same time in 10 cases, in 6 of which the fracture was transverse, and occupied both sides, with separation of the sutures in 4 ; and in 4 cases, it was limited to one side.

Fractures involving the middle zone, either by itself, or in combination with the others, are by far the most common of all fractures of the base. The middle fossa presented more or less extensive injury in 53 cases.

Transverse splitting of the skull is much more common than the longitudinal one. In 2 cases only was the skull thus split longitudinally, from the forehead to the foramen magnum. In both, the upper part of the forehead had first struck the ground, the patient having fallen several feet, and in both, there was also separation of the sagittal suture.

Modern researches have not only proved that injuries of the skull implicating the base may frequently be readily recognised, but they have also proved that the exact course of the line of fracture may not unfrequently be clearly diagnosed.

Fractures of the base of the skull, involving the orbital plates of the frontal bone, are oftentimes accompanied by an effusion of blood into the orbit and eyelids, which may become a sign of great value in the diagnosis of fractures of this region. In this decennium, the upper wall of the orbit was more or less extensively broken in 23 cases. In 8 of these cases there were no external marks of injury about the orbital region ; in 5 cases, the effusion of blood occupied the eyelids only ; but in 10 cases this effusion of blood occupying the eyelids and the cellular tissue of the orbit, gave a clear diagnosis of the nature of the injury.

In making use, however, of the bruised appearance of the eyelids as a means of diagnosis of fractures of the base, not only should the skull be carefully examined as to the spot which was struck, but especial attention should be paid to the state of the sub-conjunctival cellular tissue of the eye-ball, which will always be ecchymosed, if the blood comes from the bottom of the orbit. In such cases, the blood proceeding from the back part of the orbit makes its way forward, and at first presents itself under the ocular conjunctiva. If the patient be seen at a very early period after the accident, or if the effused blood be in small quantity, it may be altogether confined to the conjunctiva, where it first becomes visible, but this I have only seen in a very few instances; generally the blood has been effused in the eyelids, as well as upon the eye-ball. I cannot, however, quite agree with M. Velpeau in thinking that the lower lid always becomes discoloured before the upper one; that the blood does most frequently gravitate into the lower lid, there is no doubt; but I have several times seen the upper lid and sub-conjunctival cellular tissue ecchymosed, without any discoloration of the lower one. It sometimes happens, that the effusion of blood into the orbit is so extensive, that the eye-ball becomes protruded; in such cases, the fracture has been most extensive. Protrusion of the eye-ball occurred in 3 cases out of the 10 in which blood had been effused into the orbit.

Bleeding from the ear, in severe injuries of the head, is of not unfrequent occurrence, and becomes one of the most valuable diagnostic signs of fracture of the base, running through the middle fossa, and implicating the petrous portion of the temporal bone. Should this bleeding be extensive, and continue for some time, and should it be ascertained that there is a rupture of the membrana tympani, there can be no doubt, whatever may be the issue of the case, that the cavity of the tympanum has been laid open, and a communication established between it and some of the numerous vascular channels which surround the petrous bone, or with an extravasation of blood within the cranium. In 32 cases

of fracture of the middle fossa implicating the petrous bone, the tympanum was thus laid open, and its membrane ruptured in 15, or very nearly one half; the flow of blood in most of these cases was profuse and continuous, and, in all, the diagnosis of the injury was clear. Fractures of the temporal bone, however, may and do frequently occur, in which there is no sign that can lead to the supposition of such an injury. In such cases, either the line of fracture does not extend into the tympanum, or, if it does, the membrane is not ruptured, and the blood cannot consequently get into the external meatus. Fractures of the temporal bone, not involving the tympanum, existed in 12 cases; and in 5 cases, in which the tympanum was fractured, the membrana tympani was not ruptured.

But, of the signs indicative of fracture of the petrous bone, one of the surest is the copious discharge of a watery fluid from the ear, which may or may not be preceded by bleeding. In the majority of cases of this kind which I have seen, a large flow of blood preceded that of the watery fluid. In this decennium, there were only three instances in which there was a discharge of a watery fluid from the ear, after a severe injury of the head.

A man, æt. 42, having fallen off a ladder whilst lighting a lamp, was admitted into St. George's Hospital in August, 1844, under the care of Mr. Cutler, with violent bleeding from the left ear, and other symptoms of extensive fracture of the base. The flow of blood became less and less, and was ultimately succeeded, on the third day, by the discharge of a watery fluid, which continued two days, at the end of which the patient died, having had paralysis of the facial nerve shortly before his death. Among the various lines of fracture at the base, a fissure was traced from the left parietal through the squamous portion of the temporal into the petrous portion, which it cut across at its middle; and, passing backwards into the foramen lacerum posterius, reached the foramen magnum. The tympanum was laid open, and the membrane extensively ruptured. Blood had

been extensively effused between the bone and the dura-mater, principally in the region of the anterior inferior angle of the parietal.

A man, æt. 46, having fallen from a cab, was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, in August, 1849, with extensive hæmorrhage from the left ear, and slight bleeding from the nose. The bleeding from the ear gradually subsided, and was succeeded on the second day by the discharge of a slightly coloured, watery fluid, which became less and less tinged, and ultimately quite clear: it lasted two days, and the patient lived eight days after the accident, having latterly had slight paralysis of the left facial nerve. On the left side, a fissure was traced from the back part of the parietal through the mastoid portion of the temporal, and along its petrous portion into the spheno-temporal suture, traversing the tympanic cavity, and rupturing its membrane. There was little or no blood in the line of the fracture, but the cavity of the tympanum was filled with lymph.

A man, æt. 23, who, it was said, had received a blow on the right side of the head, was admitted into St. George's Hospital, under the care of Mr. Cutler, in September, 1850, with violent bleeding from the right ear, which, on the following morning, was succeeded by a watery fluid, blood-tinged: he died sixty hours after the accident, the escape of fluid from the ear continuing up to the time of his death. With an extensive fracture passing from the right parietal, in front of the zygoma, into the middle fossa, and thence across into the left anterior fossa, a small fissure was also traced out extending obliquely along the anterior surface of the petrous bone into the foramen ovale and foramen rotundum: the cavity of the tympanum, which was filled with blood, was laid open, and its membrane ruptured at its anterior part. About half an ounce of blood was found between the bone and the dura-mater, in the temporal region.

The copious discharge of a watery fluid from the ear in fractures of the base of the skull has, of late years, greatly

occupied the attention of surgeons, and many and ingenious are the explanations which have been given as to the source of this fluid; but, of all these explanations, there is none, I think, so satisfactory as that which assigns the source of this discharge to the escape of the cerebro-spinal fluid through a fissure of the meatus internus, and a laceration of the corresponding part of the dura mater, by means of which a communication is established between the cavity of the tympanum and the sub-arachnoidean cellular tissue in contact with the seventh pair of nerves; this must also be accompanied by a rupture of the membrana tympani.

That such is the origin of this watery discharge in many instances has been most clearly demonstrated by M. Robert¹ in his valuable paper, in which it appears to me, however, that the author has laid rather too much stress upon the direction of the fracture observed in his cases.

All that is wanted for the cerebro-spinal fluid to escape from the ear is, that the loose sub-arachnoidean cellular tissue which accompanies the tubular sheath of the arachnoid, belonging to the seventh pair of nerves, into the meatus internus, should be made to communicate with the cavity of the tympanum, and with the external ear through a rupture of the membrana tympani. Such a communication may be brought about, not only as stated by M. Robert, by a transverse fracture cutting the petrous bone across its middle, but also, I believe, from my own observations, by a fracture running along the anterior surface of this bone, in a more or less zig-zag direction, from the apex to the base. A fracture following either of these two directions may catch the meatus internus in some part of its course, and also run into the cavity of the tympanum; in addition to a fracture following such a course, the dura-mater lining the meatus must be ruptured, but the arachnoid accompanying the nerves may or may not be lacerated.

In the first of the three cases mentioned above, the fracture was a transverse one, and cut the petrous bone across its middle; but, in the other two cases, the line of fracture

¹ Mémoires de la Société de Chirurgie de Paris, vol. i.

ran along the anterior surface of the bone, and was more or less longitudinal in its direction.

In the following two cases which have lately fallen under my notice, the relation of the fracture to the meatus internus was traced out; and in the latter case a careful dissection, which I subsequently made, clearly revealed the extent of the injury and its exact nature.

A man, æt. 65, having been knocked down by a mail-cart, was admitted into St. George's Hospital, under the care of Mr. Keate, with severe contusion of the scalp on the left side of the forehead, and a small wound, exposing the bone, in the neighbourhood of the left superciliary ridge, but no fracture could be detected at this spot. The eyelids were closed by the effused blood, and there was profuse hæmorrhage from the right ear, and from the nose: the collapse was extreme, with perfect insensibility, and the mouth was drawn to the left side. On the following day the bleeding from the ear continued, and the sub-conjunctival cellular tissue of the lids and orbit was extensively infiltrated with blood. The bleeding from the ear gradually diminished, and was followed by a watery fluid, blood-tinged, which subsequently became quite clear. The patient lived eleven days in a semi-comatose state, and the discharge of watery fluid continued up to the time of his death. A line of fracture was traced from the left frontal, through the orbital plate, across the æthmoid and body of the sphenoid, into the right petrous bone, along the anterior surface of which it ran from the apex to the base, passing in the line of the bottom of the meatus internus; the cavity of the tympanum was laid open, and the membrana tympani was ruptured. In this case, there was no transverse fracture cutting across the petrous bone.

A man, æt. 52, was admitted into St. George's Hospital, under the care of Mr. Cæsar Hawkins, in March, 1852, with a profuse discharge of a clear watery fluid from the left ear. The patient having, it appeared, fallen four days

before his admission, in some kind of a fit, had struck the back part of his head against a stone pavement; he had been insensible for an hour after the accident, and, after recovering, had immediately noticed the discharge from the ear, which had continued ever since, and had not been preceded by any bleeding. There was a small scalp-wound, not exposing the bone, on the right side of the occipital, near the lambdoid suture, but no fracture could be detected in this or any other part of the skull. The watery fluid, of a very faint pinkish hue, dropped freely from the ear, the flow being increased when the patient was speaking; there was great pain in the head, and the patient's manner was oppressed and slow; the countenance was heavy, and of a dusky colour; the hearing, on the left side was much impaired, in fact all but lost, but there was no paralysis of the facial nerve. The patient was perfectly sensible, with a pulse laboured, and at 56. Symptoms of diffuse inflammation of the membranes soon made their appearance, and the man lived only four days after his admission into the hospital, the discharge of watery fluid having continued, with but little variation, up to the time of his death. A line of fracture was traced from the neighbourhood of the right lambdoid suture, obliquely through the occipital, to the left side of the foramen magnum: proceeding from thence through the lateral sinus, close to the foramen lacerum posterius, it reached the petrous portion of the temporal, which it cut across between the meatus internus, and the superior semi-circular canal, and having passed about midway through the thickness of the petrous bone, the fracture made a sudden bend, and then proceeded along the anterior surface of this bone towards the inner opening of the carotid canal, where it terminated. In this course the fracture at its bend just caught the bottom of the meatus internus, and, passing through the vestibule, reached the tympanum, the cavity of which was widely laid open. In addition to this fracture there was a fissure passing perpendicularly through the cribriform plate at the bottom of the meatus, and here, too, the dura-mater lining this channel

presented a corresponding laceration. The *membrana tympani* was ruptured in two different places; one of these ruptures was close to its outer margin, and the other, and larger of the two, was in the centre. There was no laceration of the lateral sinus, but the cavity of this channel, from its mastoid portion to the jugular vein, was blocked up by a firm coagulum of a rusty brown-colour, and adherent to the inner coat. No laceration was detected in any part of the *dura-mater*, save that which was at the bottom of the *meatus internus*. Extensive marks of inflammation, of a diffuse character, were found about the membranes of the brain,

In this case, previous to the dissection of the fracture, a slender pig's bristle, having been gently passed to the bottom of the *meatus*, and immediately above the nerves, made its way into the tympanic cavity, from whence, with a little management, it was brought through the rupture in the *membrana tympani*, thus plainly showing the course the cerebro-spinal fluid had taken.

It has been stated by many surgeons abroad that most of the cases of this watery discharge in fractures of the base occur in adults, or in very young persons; but, in the cases above described, the ages were 42, 46, 23, 65, and 52, and nearly all the cases of this kind, which have fallen under my own notice, have been in persons beyond the adult period of life. The *meatus internus* being larger, comparatively speaking, in the child than in the adult, may have favoured this idea; but a careful examination of a great number of skulls, fully developed, will prove that the size of the *meatus* varies very much in different heads; in some being very small, a mere chink, and very shallow, whereas in others it is of a large size, and deep. Such variations must give rise to a greater or less facility for the escape of the cerebro-spinal fluid, should a fracture occur in this part.

A close examination of these cases of watery discharge will show that this fluid makes its appearance under different circumstances. In some cases, no discharge of blood pre-

cedes that of the watery fluid, which from the beginning is all but limpid; in others, a copious bleeding precedes, and, even in these latter, the watery fluid may either imperceptibly follow the bleeding, or a certain interval, two or three days, may intervene between the bleeding and the watery discharge. Such differences may perhaps be thus explained; in the first instance, it is evident that no vascular channel has been laid open; in the second, the flow of blood masks for a time the watery fluid, which becomes more and more apparent as the blood ceases to run; in the third, the fissure being a very slight one, the clotting and drying of the blood in the tympanum and in the internal ear stop the course of the watery fluid, which gradually makes its appearance as the clots become detached. In four out of the five cases mentioned above, copious bleeding preceded the watery fluid.

M. Chassaignac¹ has endeavoured to prove that this fluid owes its origin to the filtering of the colourless part of the blood, circulating in the lateral sinus, through a minute laceration of the outer wall of this channel, caused by a fracture occupying this part of the temporal, and running through the petrous bone into the cavity of the tympanum. In addition to several other objections which may be urged against M. Chassaignac's explanation, it is impossible that, in the last-mentioned case, any fluid could have filtered from the blood circulating in the lateral sinus, as this channel was completely blocked up by coagula, evidently of some days' standing.

It has been thought by some surgeons that the watery fluid proceeds from the cavity of the arachnoid, but such cases, if they do occur, must be very rare. In this decennial period, there was only one case in which the requisites existed for this to have taken place, even had the patient survived long enough. With a comminuted fracture of the anterior surface of the petrous bone, immediately corresponding to the upper wall of the tympanum, were two small openings through the dura-mater and its arachnoid, produced by some pointed fragments of bone; the tympanum

¹ Mémoires de la Société de Chirurgie de Paris, vol. i.

was widely laid open, and its membrane torn across. In such a case, it is possible that the arachnoid, irritated by the spicula of bone, might pour out a quantity of fluid which would find its way into the external meatus.

In these remarks on the source of the watery discharge from the ear after an injury to the head, I wish it not to be inferred that I think this discharge is, in all cases, due to the escape of the cerebro-spinal fluid. That it is so in most cases, and especially in those where the fluid is abundant, and from the first all but colourless, further researches, such as those lately published by Mr. Hilton,¹ will, I have no doubt, fully demonstrate. Careful observations and dissections may, however, prove that this is not the only source of this watery discharge; but in all future researches into this subject, the exact line of the fracture, and its precise relation to the meatus internus in the whole of its length, must be most clearly made out.

In some few instances, the watery fluid is succeeded by a thin, sero-purulent secretion, which becomes thicker, and ultimately puriform: when this takes place, it is that supuration has been established along the line of the fracture of the petrous bone. Puriform lymph was in one instance found along the line of fracture, and in the cavity of the tympanum in this decennium.

Bleeding from the nose or mouth, or vomiting of blood, not unfrequently occurs after injuries of the head, but the great vascularity of the membranes lining these cavities renders this bleeding much less valuable as a diagnostic sign of fracture of the base, than that which proceeds from the ear. Still, if the bleeding be copious, and continue for some time, there is no doubt that this symptom may also become one of great value. In 32 cases of fracture of the base, implicating the central bones of this region, bleeding from the nose or mouth, oftentimes most profuse, or subsequent vomiting of blood, occurred in 14 instances, in 4 of which the fracture was confined to the æthmoid; in 3, it was confined to the body of the sphenoid, and in 1, to the basilar

¹ Clinical Lectures delivered at Guy's Hospital. (Lancet, 1853.)

process; in 5 cases, the æthmoid and sphenoid were involved at the same time, and in 1 case all these three bones were fractured.

Cases of united fracture of the base are but seldom met with; in this decennial period there was one case in which union, partly osseous and partly fibrous, had taken place in an extensive fracture of this region. It occurred in a man, æt. 53, who was admitted into St. George's Hospital, under the care of Mr. Cutler, in 1849, with a severe injury to the head, which he survived two months, and then died of erysipelas of the scalp. A line of fracture, commencing in the neighbourhood of the right parietal eminence, passed behind the external angular process, and, extending through a small portion of the great wing of the sphenoid, reached the back part of the orbital plate of the frontal, from whence it was traced through the lesser wing and body of the sphenoid, in front of the olivary process, and terminated at the inner part of the left optic foramen. This extensive line of fracture was for the greater part filled up by a deposit of new bone, and, in the situation of the lesser wing, so complete was the bony union, that all trace of the fracture had almost disappeared; but, in other parts, and especially across the body of the sphenoid, the only bond of union was a dense layer of fibrous tissue. An irregular deposit of new bone, spongy and vascular, was found on the inner side of the frontal, spreading some distance from the line of fracture, which it in some places completely overlapped.

Extensive separation of the sutures coexisted with the fractures in 14 cases, in several of which two or more sutures were implicated at the same time. Separation of the coronal suture occurred in 7 cases; in the lambdoid suture, this separation occurred in 6 cases; in the sagittal suture, there were 4 cases; in the petro-occipital, there was 1; in the temporo-parietal, there was 1; and in the spheno-parietal, there was also 1. In one case, where there was complete separation of the coronal suture, the frontal was, at the same time, extensively separated from its connections with the other bones of the cranium.

In one case, and in one only, was there a separation of a suture without a fracture; it occurred in the posterior part of the squamo-parietal suture. The temporal having been slightly separated from the parietal and driven upwards, presented, at first sight, the appearance of a fracture with depression of bone.

I cannot conclude this part of my communication without offering my warmest thanks to my colleagues, the Medical Officers, the Curators of the Museum, and the Registrars of St. George's Hospital, whose Cases and Notes have been, in the most liberal manner, placed at my disposal.