THE IMPORTANCE OF OTOLOGICAL EXAMINATION IN HEAD INJURIES, INCLUDING REFERENCE TO ITS RELATION TO RADIOLOGICAL INVESTIGATION.

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The significance of haemorrhage from an ear following a head injury is universally recognized but, in its absence, impairment of function of the auditory or vestibular mechanism is commonly overlooked until, at a later date, the patient complains of deafness or some symptom suggestive of vestibular upset. All too frequently the first otological examination is made at some considerable period after the injury. By this time the expression of opinion as to the relationship of the accident to the disability found presents considerable difficulty. The increasing frequency of road accidents and the present hazards of war result in ever-increasing numbers of cases in which this unsatisfactory circumstance occurs.

Our present object is to plead for a wider recognition of the importance of reasonably early otological examination in cases of head injury:—

1. As an aid in arriving at a more exact appreciation of the nature and extent of the injury from the otological findings themselves.
2. In respect of the help which it may be possible to give to the radiologist in his search for a basal fracture involving the temporal bone.
3. In facilitating the giving of a prognosis at subsequent examinations in cases of impairment of hearing and vestibular function.
4. In assessing attributability in respect of compensation or pensions.

For more than a year before the outbreak of war, one of us (R. B. L.), as a result of experience of several cases of "late" deafness following head injuries, was afforded the opportunity of examining all such cases at least once during some period of their sojourn in one particular hospital. Details are not available under present circumstances but the proportion of cases found to be suffering from unsuspected impairment of hearing and vestibular function was striking.

Writers on this subject stress the importance of co-operation between the surgeon and otologist but, unfortunately, the practice still appears to be far from universal. Among others, Coleman (1937 [1]) states: "The welfare of the patient with a fracture of the mastoid or petrous temporal is best protected when there is close cooperation between otologist and neuro-surgeon. These injuries frequently come within the domain of both and treatment without appreciation of this fact is not conducive to the best results." Collier (1940 [2]) states: "It is the duty of otologists to advise the casualty-service that routine examination of the ears should be made as soon as the general condition of the patient permits." Zacks (1939 [3]) concludes that "every patient with injury to the head subjectively disturbed should be examined neuro-otologically as soon after injury as possible and re-examined occasionally for approximately one year, to determine the integrity of the kinetic-static and the auditory mechanism" and further states that "while a definite objective syndrome may not be produced, vestibular tests are of inestimable value in offering a possible explanation for subjective symptomatic complaints." Alexander and Schall, quoted by Grove (1939 [4]) found objective evidence of hearing or vestibular damage in 10 per cent of 287 cases of head trauma. Vestibular disturbance was more frequent than cochlear in this series. We have been disappointed to find no reference to this subject in a discussion...
on rehabilitation after injuries to the central nervous system [5], but Symonds (1942 [6]), in a recent discussion on differential diagnosis and treatment of post-contusional states, refers to 1,020 cases of closed head injury in which true vertigo was inquired for and was found present in eighty-two. In twenty-nine of these it was associated with deafness of middle or inner ear type, dating from the injury. In four others there was a history of bleeding from the ear or tinnitus in the early stage. He suspects "that if inquiry as to the presence or absence of deafness and tinnitus, on the one hand, and diplopia and nystagmus on the other, were more vigorous in the early stages, we should have fewer cases in which corroborative evidence of labyrinthine or brain-stem injury is lacking."

Anatomical and Pathological Considerations.—Fractures of the skull (excluding those involving the facial bones) fall under two main anatomical headings: fractures involving the vault and fractures involving the base. These two varieties are combined in a large number of cases and cannot be entirely separated. Hence Stewart (1921 [7]), in an analysis of 408 fractures of the vault, found that 210 were linear and of these 70 per cent extended to the base. He states that the commonest site of basal fracture is in the middle fossa (also Logan Turner, 1936 [8]).

Fractures involving the petrous temporal bone are broadly classified as longitudinal and transverse, the former being much more common. Another type of great importance is fracture of the bony labyrinth, which can only be proved satisfactorily by the microscope but may be seen by radiological examination. Otologists are familiar with the features of these different types which are fully described in the textbooks. Colledge (1940 [9]) gives a valuable résumé of the subject.

Typically, longitudinal fractures result in damage to the middle ear while transverse fractures involve the labyrinth or inner ear. Some degree of inner ear, in addition to the middle ear, type of deafness frequently occurs in association with longitudinal fractures (Schönbauer and Brunner [10], Grove, 1940 [11]). An oblique type is sometimes referred to which combines the main characters of both the longitudinal and the transverse fracture. Fractures of the skull which do not directly involve the temporal bone may affect hearing and it has to be borne in mind that the mildest form of trauma may cause the most severe functional disturbance and vice versa [4] (also Denker and Kahler [12]). The possibility of damage to the auditory nerve itself and its central connexions has also to be borne in mind; Zacks [3] concludes that vestibular abnormalities offer an organic explanation for many so-called functional disturbances and points out that findings similar to those associated with tumour of the cerebello-pontine angle, when present, are significant and occur in a fairly large percentage of cases.

Injuries to the tympanic membrane and labyrinth damage resulting from explosions will not be discussed here.

Radiology.

Unlike fractures involving the long bones, skull fractures are usually not directly related to the clinical picture in the initial stages; this clinical picture depending upon the degree of damage to the brain. Later, after the initial phase has passed, various sequelae may become apparent, including those due to involvement of centres of special sense and nerves passing through or contained in bony cavities and canals in the base.

As a general rule, X-ray examination of the skull in head injuries is not undertaken until the patient has recovered from the initial effects of the trauma. This policy is adopted for two main reasons: (A) The undesirability of moving the patient during this phase. (B) The difficulty in obtaining satisfactory radiographs in an unconscious or semiconscious patient. The examination, moreover, is then only undertaken in many cases for the purpose of prognosis rather than as a guide to active treatment such as is the case in a fracture of, say, the shaft of the femur.

It will be admitted that in many cases of head injury radiographs are asked for as a routine and without very high hopes of demonstrating a fracture, even though clinically the presence of such a fracture seems probable. The matter is then frequently allowed to
drop with the report "no radiological fracture seen" and it is accepted that medico-legal requirements have thus been met.

With particular reference to an appreciable proportion of cases which show clinical evidence of auditory or vestibular disturbances we believe that further, and if necessary repeated, radiological investigation is desirable and should be undertaken.

In the cases so far investigated by us, projections used to demonstrate the bony structure of the base have included: Vertico-mental, Towne, Schüller (lateral mastoid), Stenver, Mayer, Occipital, several other types of oblique projections and stereoscopic views.

To multiply these to excess in any one case involves unnecessary wastage of material and time, not to mention annoyance to the patient who is still suffering from the effects of his head injury. It is therefore considered that:

(1) Special X-ray investigation for fractures involving the middle or posterior cranial fossae should only be undertaken after clinical investigation which includes the otological findings.

(2) The information received by the radiologist should, whenever possible, give him a clear understanding as to the suspected site and extent of the lesion for which he is searching.

We will not at present attempt to discuss the relative merits of different projections or the particular indications for their use.

CASE RECORDS.

All cases are examples of blunt injury due to road accidents, falls, etc.
It is regretted that conditions of active service have prevented the satisfactory reproduction of X-ray photographs.
No facilities for audiometric investigation have been available.

Case 1.—Blunt head injury. Normal tympanic membranes. Unilateral total deafness discovered six weeks later.
Lance-Corporal H., aged 26. Complains of deafness in left ear since sustaining what he was told was concussion, six weeks ago. Period of amnesia probably only about five minutes. Was in hospital for two weeks and has felt otherwise fit since then. Ears were not examined nor was he X-rayed while in hospital.

Examination.—Both drums normal. Complete deafness in left ear (with right ear excluded with noise apparatus). Slight inner ear deafness in right ear. Slight spontaneous rotatory nystagmus to right with slight past-pointing to left. No other neurological signs present.

(Existing circumstances rendered further investigation impracticable nor has it been possible to obtain any subsequent information about this case.)

Case 2.—Blunt head injury with aural discharge—resolution, but persistent deafness. Severe unilateral mixed middle and inner ear deafness with loss of vestibular function discovered three years later. No radiological evidence of fracture of temporal bone.
Serjeant M., aged 38. While recovering from otitis externa, found to be very deaf in left ear. Gives a history of sustaining a head injury in a lorry accident three years previously but had no recollection of details of the accident or of circumstances immediately preceding it. He was unconscious for several days. His left ear discharged thereafter but it was never examined or treated and it dried up in a few weeks but he has never heard well with it since.

Examination.—Right drum normal. Left drum small posterior scar. Hearing in right ear normal. Mixed middle and inner type of deafness in left ear, in which he can only hear a raised voice close up (with right ear excluded with noise apparatus). No spontaneous vestibular signs present. Cold caloric test: right ear—normal reactions in fifty seconds. Left ear—no reaction after four minutes. X-ray: lateral mastoid projection—slight relative obscurity of left mastoid air cells. No evidence of fracture seen. Stenver projection—no evidence of fracture seen.

Comment.—In neither of these cases had the ears been previously investigated yet, from the findings here recorded, the importance of such an examination soon after accident is obvious in both.
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Corporal M., aged 29. Head injury due to being thrown from a horse. Remembers incidents up to the actual fall but period of amnesia is very uncertain. X-ray: lateral skull projection—fissure fracture of left parietal and squamous temporal bones. Examination: both drums normal. Hearing normal in both ears. No symptoms or signs of vestibular disturbance.

Comment.—This case demonstrates the value of negative otological findings where there is radiological evidence of a fracture of the vault. Further radiological investigation was unnecessary.

Case 4.—Blunt head injury with haemorrhage from left ear and also right haemato tympanum with no external haemorrhage.
Private R., aged 34. Head injury due to a car accident. Remembers nearly reaching destination but no details of events leading to the accident. On admission to hospital: conscious, drowsy, bleeding from left ear.

Examination.—Left external ear contains blood-clot and fresh blood. Right drum intact but bulging, with blood present in the middle ear (haemato tympanum). Pure middle ear type of deafness present in both ears. X-ray: antero-posterior and lateral projections—no fracture seen. (Further radiological investigation was not practicable.) Eight weeks later—right drum normal. Left drum shows a small posterior scar. Hearing in right ear normal, slight middle ear deafness still present in left ear.

Comment.—In this case the lesion in the right ear would have been entirely overlooked if routine examination had been omitted.

Case 5.—Blunt head injury with haemorrhage from left ear which became secondarily infected. Right chronic otitis media. Fracture involving left middle cranial fossa.
Rifleman L., aged 33. Head injury due to lorry collision. Does not remember actual impact. First memory after accident is of waking up in hospital, one and a quarter hours later. Bleeding from left ear on admission.

Examination.—Thirty-six hours after accident: Left ear contains debris and blood-clot. Right ear contains pus with a polypus present. No blood-clot seen—chronic suppurative otitis media. Patient is not sufficiently co-operative to render hearing tests reliable but it is noted that he seems to rely on the left ear for hearing. No signs of vestibular disturbance. C.N.S.—no abnormality detected. Sulphonamide given. Two and a half days after accident: left facial paresis noted. X-ray: lateral skull and lateral mastoid projections and stereoscopic lateral view—linear fracture of left parietal region extending through temporal region to middle cranial fossa. Right mastoid is acellular, left is cellular, with no evidence of infection. Subsequently the left middle ear became infected and hearing tests demonstrated pure middle ear deafness in both ears. Four weeks after the accident: left ear dry and facial paresis has recovered completely. Six weeks after the accident hearing in the left ear almost normal. The polypus was subsequently removed from the right ear but it did not become dry and hearing remained poor.

Comment.—This case presents several interesting features:—(1) Had the fracture occurred on the right side, in the presence of a chronic otitis media the desirability of carrying out a mastoid operation would have required consideration. The advent of the sulphonamide drugs would provide a subject for fruitful discussion in this connexion. (2) The occurrence of secondary acute infection in the left ear actually did present this very problem, in which X-ray proved helpful—(a) by demonstrating a cellular mastoid, this making the presence of long-standing infection improbable, (b) by demonstrating no evidence of mastoid infection at the time of examination. (3) Facial paresis. Schönbauer and Brunner[ 10] state that the prognosis is usually favourable in this (longitudinal) type of fracture, whereas in transverse fractures, it is bad. Grove [11] states that late paralysis, as in this case, is due to haemorrhage into the nerve canal. Coleman [1] finds that it is rarely permanent and usually appears a few days after the injury. O'Connell (1941 [13]) also finds that the prognosis seems usually to be good. Stewart [7] found three cases of persistent facial palsy out of 295 who recovered from fractures of the skull.
Case 6.—Blunt head injury with ? haemorrhage from ear. Otitis externa prevented inspection of drum. Fracture involving middle cranial fossa. Persistent unilateral middle ear deafness.

Lance-Corporal F., aged 28. Fell and struck his head on a stone floor. He had not felt well and had gone to bed but got up to get a hot drink. While doing so he felt faint and next remembers waking up in hospital several days later. Dried blood noted in left ear on admission to hospital—? from scalp wound. X-ray: lateral projection—fracture in left posterior parietal region passing down towards middle fossa.

Examination (two weeks after injury).—Right drum normal, left ear—otitis externa, very swollen meatus, no blood-clot present, inspection of drum impossible. Hearing normal in right ear. Pure middle ear deafness present in left ear in which whisper is heard at one foot. No signs of vestibular disturbance. Further X-ray examination: Schüller projection—fissuring of left parietal region involving squama. A small fissure of squama passes down into middle fossa. Stenver and Mayer projections—show no evidence of fracture. Seven weeks after injury—left drum almost normal with small posterior scar. Hearing unchanged.

Comment.—The presence of otitis externa rendered an accurate assessment of the ear condition difficult in this case and further X-rays proved of particular value in the circumstances.

Bleeding from an ear after a blunt head injury is almost pathognomonic of fracture of the temporal bone. Grove (1939 [14]) discusses this subject in detail and we would here only mention two possible sources other than the middle ear itself: (1) the possibility of blood entering the external ear from some independent external source of haemorrhage, as was suspected in this case. (2) injury to the external canal caused by sudden impaction of the mandible against the glenoid fossa.

Case 7.—Blunt head injury with hemotympanum but no external haemorrhage. Fracture involving middle cranial fossa—confirmed at post-mortem.

Private V., aged ? Fell 20 feet from a window. Admitted to hospital unconscious, with a wound 4 inches long in right parietal region. C.N.S.—signs of widespread cerebral lesions causing nearly total motor paralysis affecting cranial (and peripheral) nerves except for some signs of active movements in left arm. X-ray: Skull fracture on right side extending from frontal sinus, backwards through frontal and parietal bones and downwards into the petrous portion of the temporal bone. Left drum normal. Right drum intact, blood present behind the drum which is bulging. Ecchymoses of posterior-superior well of external meatus. Died in thirty-six hours. X-ray findings confirmed at post-mortem.

Comment.—This case again demonstrates that fracture and haemorrhage into the middle ear can occur without rupture of the drum.

Case 8.—Attacks of vertigo commencing two years after a blunt head injury. Hearing normal. Marked inequality of right and left vestibular reactions. Fracture involving right middle cranial fossa.

Corporal C., aged 30. Fell from a horse in 1934 and was unconscious for about five minutes. He remembers events up to the moment of impact. Two years later he had an attack of vertigo which has since recurred at intervals of several months. Attacks appear to be initiated by stooping and last for one to two minutes. He has never actually fallen during an attack but has to sit down or hold on to something. No headache, nausea or vomiting. Attacks never wake him up from sleep.

Examination.—C.N.S.—no abnormality detected. Both drums normal. Hearing normal. No spontaneous vestibular signs. Cold caloric test: marked delay in reactions on right side compared with left at repeated examinations. X-ray: Stenver projection shows some irregularity of outline of the superior aspect of the right petrous, with a small fissure passing down from the squama into the shadow of the petrous. The appearance suggests a fracture of the middle fossa passing from the squama, medially.

Comment.—The cause of disability is open to doubt but, after prolonged observation the consensus of opinion was that this man's symptoms were related to the injury sustained in 1934, the result being some upset of vestibular function. Epilepsy cannot however be definitely excluded, though from witnesses, attacks have not apparently been associated with tonic or clonic movements. Denker and Kahler [12], quoting Rhese, point out that
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The vestibular nerve is more resistant to injuries than the cochlear nerve and therefore if there is normal hearing but decrease of vestibular function the lesion may be regarded as central. A record of the vestibular findings soon after the accident would have been of much value in trying to determine the nature of these attacks. Further X-ray investigation would have been of interest but unfortunately the utilization of additional films did not appear to be justified.

Case 9.—Blunt head injury with fracture involving right middle cranial fossa. Old healed bilateral otitis media. Hearing in left ear normal, mixed middle and inner ear deafness in right ear, with marked relative impairment of right vestibular reactions.

Private C., aged 31. Sustained a head injury in a road accident with laceration of scalp in right parietal region. He remembers no details of the accident and woke up in hospital a few days later. Four days later: C.N.S.—no abnormality detected. No bleeding from either ear has been observed. X-ray: 1: lateral fracture running across right temporal and parieto-occipital region. Two weeks after accident patient observed deafness in right ear.

Examination.—Both drums are grossly scarred. Appearances suggest that this is the result of previous suppurative and not of recent origin. Hearing in left ear normal. Mixed middle and inner ear deafness present in the right ear. Hearing in right ear improves slightly after inflation, but spoken voice is only heard close up (with left ear excluded with noise apparatus). No spontaneous vestibular signs present. Cold caloric test: Left ear—normal reactions after twenty-five seconds. Right ear—very transient reactions after ninety seconds. X-ray 2: Stenver projection—fissure involving upper right mastoid region and running forwards into the middle fossa. 3 Schuller projection—fissure in the mastoid previously seen is not confirmed but there is a crack in the adjoining cranium running downwards and forwards into the middle fossa.

Comment.—The middle ear deafness which was present in this case would appear, almost certainly, to have been due to previous middle ear infection while the inner ear deafness, along with the impairment of vestibular function, can reasonably be considered to have resulted from the trauma.

Case 10.—Blunt head injury followed by vertigo. Normal hearing. Inequality of right and left vestibular reactions. Fracture of left mastoid temporal bone.

Sergeant P., aged 41. Struck behind left ear by a metal rod eleven weeks ago. He remembers events right up to the accident. He was unconscious thereafter but does not know for how long. Subsequently he has suffered from vertigo and tinnitus in left ear but has never noticed any deafness. Giddy turns continue to come on suddenly and without warning and last for fifteen to twenty minutes. Always feels persistently giddy whenever he lies on his left side but cannot state in which direction objects appear to move. Has never fallen and does not suffer from nausea or vomiting. Attacks never wake him up from sleep but he cannot sleep on his left side.

Examination.—Both drums normal and hearing normal in both ears. No spontaneous vestibular signs. C.N.S.—no abnormality detected. Blood Kahn negative. B.P. 130/85. Cold caloric test (repeated twice): Right side—normal reactions after forty seconds. Left side—violent reactions in thirty seconds; and he volunteers the information that it reproduces the attacks from which he suffers. X-ray: Stenver projection shows a fissure through the left mastoid passing upwards and forwards into the region of the internal ear.

Comment.—The vestibular hyperirritability associated with this fracture is an interesting feature. Unfortunately further observation was impossible and efforts to obtain subsequent information have been unsuccessful.

Summary.

1. Attention is directed to the importance of carrying out otological examination in all cases of head injury.

2. It is suggested that closer co-operation between the otologist and the radiologist would facilitate radiological investigation of fractures of the middle and posterior cranial fossae.

3. Brief notes of ten cases are given, with comments.
We desire to express our thanks to Colonel A. T. B. Dickson for permission to forward the notes of Cases 1, 2, 3, 4, 6, 8, 9 and 10 and to Colonel H. D. F. Brand for permission to submit Case 5.

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REFERENCES.