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GUNSHOT WOUNDS OF THE HEAD*

(A Review of the After-effects in 500 Canadian Pensioners from the Great War, 1914-1918)

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DURING the past few years, more especially since the start of the present war, many articles have been written relating to the after effects of head injuries, and much thought has been given to the subject, particularly if these head injuries are caused by metal projectiles. These articles generally stress the seriousness of head injuries, and mainly centre around the probability of the development of epilepsy.

Many varying statements have been made in reference to the frequency of epilepsy: Ascroft, in the *British Medical Journal* of May 17, 1941, stated that 34% of head injuries had developed epilepsy and that, where the dura had been penetrated, 25%; Cushing's statistics show that epilepsy developed in 45% of non-penetrating injuries and 36% of penetrating injuries; Credner states the incidence is 49.5%; Rawley found 25%; Wagstaffe, in his review, shows an incidence of 9.8% of epilepsy and, if the dura is penetrated, 18.7%.

In order that an unprejudiced and independent review of the after-effects of gunshot wounds of the head might be prepared, the officer in charge of records for the Department of Pensions and National Health was asked to provide a list of 500 cases of individuals in receipt of pension for these after-effects. The cases were obtained, therefore, from the pension lists, not from the treatment statistics of any hospital or clinic.

* Summary of a paper presented before the Montreal Neurological Society, March 17, 1943.

Before considering the statistics compiled in this review of 500 cases, some points should be emphasized. The statement made by Stephenson that statistics considered by medical observers are fallacious, as only cases requiring treatment are reviewed, does not apply to this particular review, noting that these 500 cases were obtained from the pension lists, not the treatment statistics of any hospital or clinic. In 1936 these men were alive and in receipt of pension for disability resulting from a head wound. Twenty-three (4.6%) have died since of various causes, one only (status epilepticus) as a direct result of the head injury. There was no selection of cases, except that only gunshot wounds of the cranium were included. All gunshot wounds of other than the cranial bones were eliminated, as were also head injuries resulting from accident, such as motor car mishaps. All cases having had one incident labelled epilepsy or epileptiform at any time following the head injury are included as having epilepsy.

The 500 cases reviewed show 49 cases of epilepsy, *i.e.*, 9.8%. Other articles state that in any series of cases there must be some epileptics that are missed. Even if this were possible with the pension and treatment system in effect in Canada, it would apply at least equally to this review. Also, some are listed as epileptic when it is fairly definite that the condition should not have been diagnosed as epilepsy.

The first table indicates the tissue involved in the injury, *i.e.*, the scalp, fracture with the dura intact, and fracture with the dura penetrated or torn. If, from the documents, there is a doubt, the case is not listed as showing penetration or tearing of the dura. However, if there has been a penetrating foreign body which either has remained in the brain or has been removed, it is considered the dura has been torn, although not specifically mentioned.

This table shows that of the 500 cases, 130 were scalp wounds, *i.e.*, 26%; some noted as being dirty and infected. Of these, as indicated by the first black shaded portion of the graph, five had at one time shown epileptic attacks. This means that 3.8% of the scalp wounds are listed as epileptic, and of the total number of epileptics, 10.2% followed scalp wounds.

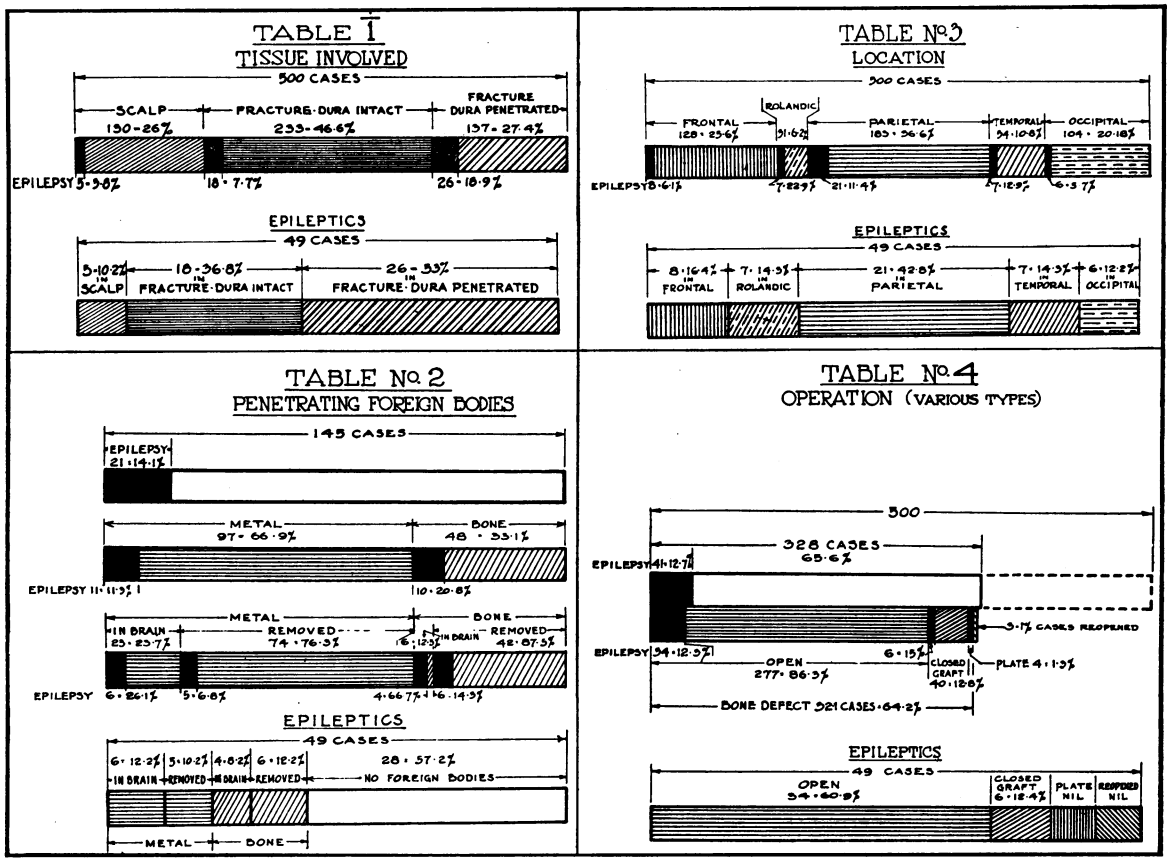
The second portion of this table shows that a total of 233 cases, or 46.6% of the cases re-

viewed, had suffered fracture without tearing or penetration of the dura. Of these, 18, or an incidence of 7.7%, are listed as epileptics. Of the total number of epileptics, therefore, 36.8% are in this category.

The third section of this table refers to the cases with fracture and penetration of the dura. These totalled 137, *i.e.*, 27.4% of the cases reviewed. Of these, 26 are shown as epileptic, which means that the incidence of epilepsy is 18.9% if the dura is penetrated. Also, of the total number of cases of epilepsy, (49), 26, or 53% are in this class. This agrees with statements made in other reviews indicating that the liability to the development of epilepsy is greater if the dura is damaged. However, 18.9% is much less than the 45% as given by Ascroft, the 49.5% by Credner, or the rough estimate of 40 to 50% given by Cairns, but practically the same as the 18.7% arrived at by Wagstaffe.

The second table deals with the cases where penetration of a foreign body into the brain substance is definitely proved either by evidence at the time of operation or x-ray examination. These total 145, or 29% of the cases reviewed. Of these 21, or 14.1%, show epilepsy.

These cases are subdivided into whether the foreign body is metal or bone, and also whether removed or remaining in the brain tissue. Only those cases in which complete x-ray examination, repeated after discharge from the army, confirms the presence of a foreign body in the brain substance are listed as such.



The total cases showing metal penetration number 97, with 11 cases of epilepsy, or an incidence of 11.3%. Of these, in 74 cases the metal was removed and there are 5 cases of epilepsy, or an incidence of 6.8%. With the metal remaining in the brain tissue are 23 cases, 6 of which show epileptic attacks, or an incidence of 26.1%. With penetration of bone there are 48 cases, 10 of which are epileptic, an incidence of 20.8%. Of these, in 42 cases the bone fragments were removed—6 cases of epilepsy or an incidence of 14.3%, and there are six cases in which bone fragments are demonstrated as remaining in the brain, 4 of which are epileptic, an incidence of 66.7%. There is probably a rather large percentage of error here, as numerous cases with bone frag-

ments remaining in the brain substance are missed at subsequent examinations.

Of the 49 cases listed as epileptic, 21, or 42.8% are in the category of penetrating foreign bodies. These are practically equally divided as follows:

Metal removed	10.2%
Metal in brain	12.2%
Bone removed	12.2%
Bone in brain	8.2%

It will be noted, therefore, that although the incidence of epilepsy is 18.9% where the dura is torn, it is, however, only 14.1% where there is definite evidence of the damage having been done by penetrating foreign bodies. Several cases noted at time of operation a tearing of the dura where there has been no penetrating foreign body. Also, the incidence of epilepsy would appear to be much higher when the foreign body is bone, rather than metal, and very high if a bony foreign body has remained in the brain substance.

Table 3 indicates the location of the original injury. If more than one cranial bone was involved, the site of the injury is considered to be where the major part of the damage has been done.

The frontal area shows 128 cases, or 25.6% of the total cases reviewed, with 8 cases of epilepsy; *i.e.*, an incidence of 6.1%.

The Rolandic area shows 31 cases, *i.e.*, 6.2% of the total, with 7 cases of epilepsy, an incidence of 22.9%. Undoubtedly there is an error here, as only those cases are listed as being in the Rolandic area where the area is definitely mentioned, or where there has been a hemiplegia or monoplegia. Many of the cases listed in the next section (parietal area) doubtless involve the Rolandic area of the brain, either directly or by a foreign body travelling at an angle from the point of entry.

The third subdivision is the parietal area, with a total of 183 cases, or 36.6% of the total, with 21 cases of epilepsy, an incidence of 11.4%.

The temporal area includes 54 cases, or 10.8% of the total, with 7 cases of epilepsy—12.9%.

The cases in the occipital area are third in frequency, with a total of 104 cases, or 20.8% of the total with 6 cases of epilepsy, an incidence of 5.7%.

These figures show that the incidence of epilepsy is undoubtedly, even allowing for error, greater if the Rolandic area is involved.

Considering the total number of cases of epilepsy (49) the following percentages are arrived at:

Frontal	16.4%
Rolandic	14.3%
Parietal	42.8%
Temporal	14.3%
Occipital	12.2%

Table 4 indicates the number of cases (328, or 65.6% of the total) in which there is a definite note on the service documents of an operation having been performed. These operations vary from excision of damaged scalp tissue to removal of bone with exploration of the brain and removal, if possible, of foreign bodies.

In these cases there are 41 epileptics, *i.e.*, an incidence of 12.7%. The case records show a total of 277 cases where a portion of the skull has been removed and no closure attempted. Of these, 34 are epileptics, an incidence of 12.3%. In 40 cases the opening was closed with either a cartilaginous or bone graft, 6 of whom, or 15%, are epileptic. Four cases were closed with a plate, and there were three cases where the graft was removed, none of which show epilepsy.

Of the total number of cases of epilepsy (49), 34, or 60.9%, show an opening in the skull, and six, or 12.4%, where the opening has been closed with a graft.

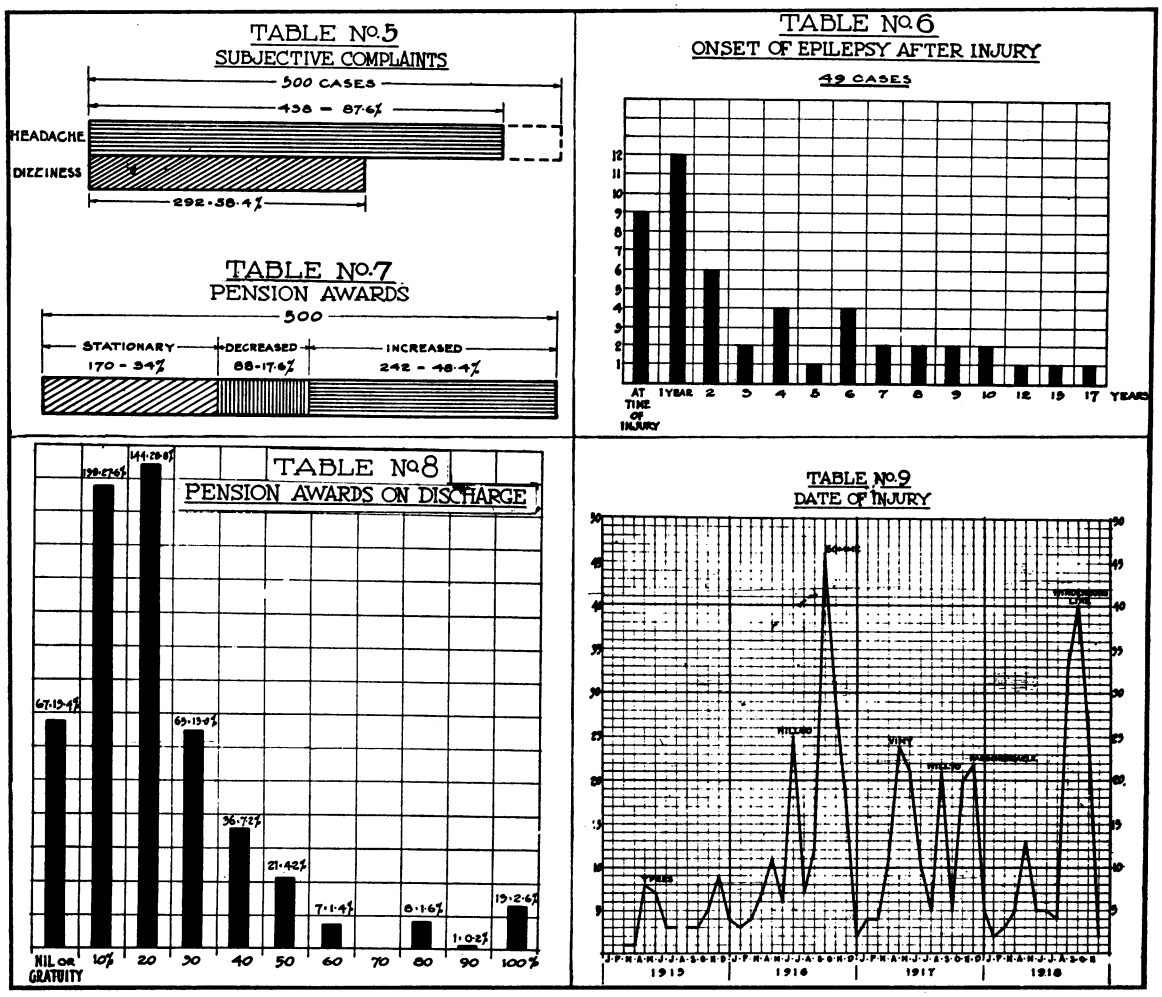
The incidence of epilepsy in these cases is therefore slightly higher than the average, but it is considerably less than where there has been a penetrating bony foreign body, and also where the foreign body, either metal or bone, has remained in the brain substance.

Table 5 refers to the incidence of the subjective complaints of headache and dizziness regardless of the location, type, or result of the original injury. In 438 cases, or 87.6%, there is found on the documents complaint of headache, generally first mentioned during the convalescent period following the period of hospitalization for the injury. This complaint is variously described as head pain, generalized headache, or headache localized to the area of injury on the scalp. If there has been a penetrating wound or a retained foreign body at some distance from the point of entry, the head pain is either general or localized to the point of entry on the scalp, not where the actual damage to the brain tissue has been done.

The cases where dizziness is recorded total 292, or 58.4% of the total, generally described as occurring only on stooping or lifting.

It was noted in reviewing these cases that if a severe after-result of the head injury was present, such as a persistent hemiplegia, the complaint of headache was not made, whereas, on the contrary, patients with a superficial scalp wound or fracture of the outer table stated to be severe and fairly continuous, does not appear to interfere materially with employment.

The statement has been made that dizziness following head injury is more or less the equivalent of epilepsy. However, this review shows that the subjective complaint being present in practically 60% of the cases, indicates that this complaint of dizziness is far



would complain of severe and persisting headache out of all proportion to the extent of the injury.

It is also noted that the headache continued in spite of post-discharge treatment, which appears to have very little permanent effect on the complaints. Following encephalogram there may be stated to be a temporary relief, but within a year or at the time of the next pension examination, the complaint of headache is just the same as it was before. In only six cases is there noted the excessive use of aspirin or sedatives. The headache, even when more frequent than any definitely recorded frequency of epilepsy.

The rôle of sepsis accompanying or following a head injury as a cause of future complications, such as epilepsy, has received considerable attention. From this review it was not considered possible or advisable to make any very definite statement. Unfortunately, many of the references contained in the army documentation to infection are vague and in other instances, where from the description of the injury, sepsis would be expected, it is not mentioned in the case reports.

Cerebral herniation is apparently very infrequent. In this entire series the condition is described in only 3 cases.

Table 6 indicates the duration of time between the injury and the first recorded epileptic attack. The majority of cases of epilepsy (21—43%) appear during the first period of hospitalization or in the first year following the injury. It will be noted that one case did not show epilepsy until seventeen years after the gunshot wound.

Tables 7 and 8 should be considered together and are of interest as indicating the degree of disablement following a head injury.

It will be noted in Table 7 that 34% of the original awards remained stationary, and 17.6% were decreased prior to December 31, 1942. Less than one-half, or 48.4%, had been awarded an increase in pension over the number of years since discharge from the army: this in spite of changes of legislation, difficult economic conditions, and other factors. Combining these two tables would show that the head injury case is not seeking compensation, but has been re-established. It was even noted that some had enlisted in the present war.

Table 8 shows the degree of disability as assessed for pension purposes at the time of discharge from the armed services. It is interesting to note that 67, or 13.4%, were assessed as negligible, or were awarded a gratuity. The Canadian Pension awards of monthly payments based on an assessment of the individual's abilities in the general labour market, start at 5%. Including those not granted pension, the total up to and including awards of 30%, is 414 of the 500 cases reviewed, or 82.8% of the total. As pension assessments are generous, and dependent largely on subjective complaints, this would surely indicate that the degree of disability after a head injury is not very great.

Table 9 is merely of interest, indicating that the occurrence of the injuries coincides with the larger engagements in which the Canadian Forces participated.

Statistics were also kept of the length of time between the injury and discharge from the forces, although not prepared in table form. These show that 61 cases, or 12.2%, were discharged within six months; 178, or 35.6%, within a year; and 135, or 27%, up to a year and a half. Therefore, 77.2% remained under hospital treatment and in convalescent camps up to one and a half years following the injury. This would not appear to be too high an average. The majority who remained in the army for a longer period of time were returned to duty and were not discharged until demobilization.

To summarize, a review of 500 Canadian ex-service men from the last war receiving pension for the after-effects of gunshot wounds of the skull show an incidence of epilepsy of 9.8%, which is undoubtedly the maximum.

Where the dura was torn the incidence increased to 18.9%.

Retained foreign bodies apparently increased the incidence of epilepsy—retained metal being 26.1%, and retained bone 66.7%. Of course, a review of another series of cases might alter these percentages, especially that of retained bone.

The frequency of epilepsy is greater if the Rolandic area is damaged.

The type or location of the injury does not appear to affect the subjective complaints, as 87.6% show a record of headache. Operative procedures after discharge did not appear materially to affect these complaints.

As 58.4% show complaints of dizziness, this can hardly be considered as an epileptic symptom or equivalent, especially as over a long period of years no other signs or symptoms developed, and there is no indication of the epileptic constitution.

The occupational handicap following head injury is not great, as 82.8% are assessed at 30% or less, and the assessments of the Canadian Pension are generous.

RÉSUMÉ

Sur 500 ex-soldats de la guerre de 1914-18, pensionnés pour séquelles de blessures crâniennes par armes à feu, 9.8% présentent des crises épileptiques. Dans les cas où la dure-mère a été lacérée, la fréquence de l'épilepsie monte à 18.9%. Quand des particules métalliques ou osseuses restèrent dans la plaie les convulsions subséquentes furent encore plus fréquentes: 26.1% dans le premier cas et 66.7% dans le second. L'atteinte de la zône de Rolando est particulièrement épileptogène. Dans tous les cas, la céphalée figure dans un pourcentage de 87.6%, les malades opérés inclus. Les 58.4% des cas qui se plaignent de vertiges ne sont pas intégrés dans la statistique d'épilepsie. En général, les malades peuvent travailler sans gros handicap. JEAN SAUCIER