Head injuries

My interest in head injuries was first stimulated when I was privileged to work, as neuropathologist, with Professor Sir Hugh Cairns during and after the late war. Largely as a result of his far-sighted vision the cases of head injury from the three Services were gathered together in Oxford and, thus, those working there had the opportunity to study cases which had an extraordinary range of damage to the brain and spinal cord, with causes varying from gunshot wounds to road accidents. It seems unlikely that such a number and variety of cases will ever again be seen in a single centre.

One of Cairns' many contributions was to press for the introduction of crash helmets for Army despatch riders using motor cycles. As soon as these became compulsory there was a dramatic decrease in the number of head injuries amongst despatch riders. Since regeneration in the brain is ineffective, the prevention of head injuries is of the greatest importance and it seems to me that in the future the wearing of seat belts, which reduces head injuries in car accidents as dramatically as crash helmets diminished them for the motor cyclist, will have to be made compulsory and that insurance companies will have to refuse to pay claims by those who have failed to wear their belts.

The success of the Oxford centre made it clear that in the future, if cases of civilian head injury were to be properly treated, there would have to be specialized units. No one today can doubt the fact that serious head injuries should be investigated at an accident centre in which, in addition to orthopaedic experts, there is a neurosurgical team supported by neurologists, neuroradiologists, neurophysiologists, and neuropathologists. Although the subdural haematoma is so common and so fatal, its treatment, once the lesion is suspected and located is one of the simplest in neurosurgery and it is tragic that many patients die of this condition because they are not under the care of specialists whose expertise lies in the neurological field.

There is at the present time throughout the world one cause of death and disability which is becoming as serious as any of those infective epidemics which decimated countries in mediaeval times and induced in the populace a feeling of utter hopelessness; this is the modern 'epidemic' of head injuries. There does not seem to be any more likelihood of relief in the foreseeable future from this plague than our forefathers had from theirs. Head injuries, increasing so rapidly as a result of road accidents, are not confined to the so-called developed countries with their high densities of motor vehicles, but are also mounting in countries where the density of traffic is low, but where high speeds are just as attractive to the driver as they are in the highly developed regions. In road traffic accidents the head is more commonly damaged than any other part of the body, and with a steady increase in such accidents it is obvious that more and more people throughout the world will suffer from head injuries.

In the past virtually all advances in both prevention and treatment of disease have come from increasing knowledge derived from the study of pathological processes. In the seventeenth century the physician could safely pronounce that his patient was suffering from some bilious complaint or some unpleasant humour with the happy knowledge that the victim would be buried with the diagnosis unquestioned while the physician's prestige and all-knowingness would remain as assured as ever, whatever the real disease might have been. With the development of morbid anatomy this state of things, so satisfactory to the medical man, altered and the physician soon had to improve his diagnostic acumen or to be exposed at the necropsy as a charlatan. The development of pathology, in all its branches, especially in this century, has

been breathtaking, and with it the diagnostic and curative side of medicine has reached a level which would have been unbelievable a short time ago. Unhappily, for various reasons, knowledge of the pathology of the brain has lagged behind that of other systems. The extreme complexity of the brain and the difficulties lying in the way of its investigation have, I believe, caused many able research workers to turn to other fields where the rewards in the form of new knowledge are likely to come more quickly. In the special case of head injuries a system, such as the one in this country, which ensures that virtually all cases dying of a head injury will go to the forensic pathologist excludes the possibility of a full pathological examination of the nervous system. The forensic pathologist has neither the time nor the knowledge to examine the brain adequately. His almost universal practice of cutting the fresh brain makes certain that most lesions, apart from the usual uninteresting and not very informative contusions, will be missed.

Until very recently, virtually nothing had been added to our knowledge of the pathology of the brain in head injuries, but in this symposium there is recorded some extremely valuable work, which advances the subject considerably. Again we owe to Cairns the stimulus which started much of this work. He had the vision to see that a knowledge of the physical principles governing movement of the brain within the skull and the stresses and strains to which the soft brain was subjected was essential to any advance in knowledge. At the beginning of the war Cairns was fortunate in getting an exceptionally able and thoughtful physicist, Hilas Holbourn, interested in the problems of damage to the brain in head injury and Holbourn, using jelly-like models and applying physical principles to his problem, laid the foundations of a scientific understanding of brain injury. About this time we were much puzzled by a series of patients who had suffered closed head injuries, often of a seemingly trivial character, but who after the injury remained in a state usually described as one of coma. The survival of these patients depended wholly on the nursing care which they received and a number lived for months or even years in this state. At necropsy their brains showed remarkably little sign of damage, with only perhaps a few small, healed cortical contusions and a very modest degree of internal hydrocephalus. With the pressure of other work these cases were not studied adequately and their pathology remained an enigma. Fortunately, soon after the end of the war Dr Sabina Strich came to work in the neuropathological laboratory which was attached to Cairns' department in Oxford and was persuaded to study these intensely interesting but also deeply puzzling brains. By making an intensive study of a few very well documented cases she was able to reveal lesions in the cerebral hemispheres and brain stem, whose distribution and characteristics could, in general, be accounted for by the physical forces which Holbourn had shown must be acting on the soft brain substances at the time of impact. This early study by Dr Strich illustrated the importance of good clinical documentation of cases which are to be used for research by pathologists. For example, it was recorded of one patient that she had taken up a decerebrate posture at the very moment of impact, which showed that the blow to the skull had damaged the brain instantaneously and that the lesions eventually found could not have been due to causes such as oedema. Another observation of very considerable interest by Dr Strich was that these patients were not in coma, since they had periods of sleep and of wakefulness, but that they were in fact profoundly demented. The paper by Dr Strich, in this symposium, records her wide experience of the pathology of head injuries over the best part of 20 years' study.

For many years the clinical features presented by patients who had suffered injuries to the brain of the shearing type described by Dr Strich were explained on the assumption that the cerebral hemispheres were not damaged at all, but that the injuries were confined to the brain stem. Dr Tomlinson gives a most valuable survey of the damage to the brain stem found in a large number of cases of head injury, stressing that there are a number of causes for the lesions found here. In some cases the damage is due to shearing of nerve fibres, in others small infarcts predominate, probably caused by the stretching of brain stem vessels at the time of impact, the same movement of the brain stem leading both to damage of nerve fibres and of small

vessels. These primary lesions are commonly found in identical sites in different patients, which again points to a similar cause for both vascular and nerve fibre damage. The secondary lesions in the brain stem found in cases of raised supratentorial pressure, from whatever cause, are well known to all neurologists, neurosurgeons, and neuropathologists, and are indeed the commonest eventual cause of death in such cases. Dr Tomlinson surveys the damage found in the brain stem of patients suffering from raised intracranial pressure caused by their injury. The importance of this part of his paper is emphasized by the excellent contribution of Professor Jennett whose studies of the role of blood supply and oxygen tension in the aetiology of secondary damage to the brain in cases of head injury are of the greatest importance. For, as Professor Jennett points out, although the clinician cannot undo the damage caused by the injury he should eventually be able to prevent secondary damage due to brain swelling. The need for research here is very apparent, and with the advance in methods of studying blood flow, intracranial pressure (for which equipment is now available), and so forth, the rewards during the next few years should be great.

A region which has been much neglected by the neuropathologist is the hypothalamus. This neglect is doubtless due in large part to the necessity for good anatomical knowledge of a complex area and also to the fact that for any adequate investigation it is virtually essential to work on serial sections. The hypothalamus and the pituitary gland, connected as they are by a nerve tract and a uniquely complicated system of blood vessels, are inseparable and Dr Treip has been investigating the pathology of these regions for a number of years. He has made particular efforts to get good clinico-pathological correlations in cases of head injury in which the hypothalamus is involved. One of the difficulties here, in the clinical field, is that in a considerable number of cases, owing to various difficulties, records of water balance and electrolytes are not adequate. However, Dr Treip has presented much information on both hypothalamic and pituitary damage which is not, at present, available elsewhere. The importance of a proper investigation of the hypothalamus in cases of head injury is indicated when one appreciates that in a number of cases of the type described by Dr Tomlinson there will be additional lesions in the hypothalamus. And again, hypothalamic damage may be an additional factor in that secondary damage to the brain which Professor Jennett is trying to avoid.

Dr Poole's section is concerned essentially with the help that the electroencephalogram can give to the clinician in the diagnosis of the lesions present, in avoiding the development of secondary damage, and in prognosis at various stages. In spite of the imprecision of the EEG when compared with the precision of the needle electrode wielded by the experimental neurophysiologist it is quite clear that the clinical electrophysiologist is an essential member of the team concerned with head injuries.

These papers leave one in no doubt that the day of macroscopic investigation of the pathology of head injuries is long past and that in the future advances will only come as a result of painstaking microscopical work. They also point clearly to the need for extensive physiological and chemical investigation of patients with head injuries. The difficulties of animal experimental work in this field are largely due to the small size, relative to the human, of all animal brains, a fact which means that the physical forces distorting the brain tissue are much less than those in the large human brain. However, it is clear that advances will be made in this field if adequate resources are made available for experimental work.

The concentration in this part of the symposium is on the sequelae in the brain from direct trauma applied to the head, but we must not overlook the effects of trauma to other parts of the body on brain function. This has been much neglected in recent years, but the growing appreciation of the role of the central nervous system, particularly of the hypothalamus, in homeostatic regulation is leading to an increasing volume of research into its role in the response to injury. We are fortunate that Dr Kovách has reviewed this subject for us. He and his team in Budapest have for many years been studying the effects of haemorrhage and other forms of injury on the function of the brain. Their work has shown that distant injuries give rise

many important changes in cerebral blood flow, metabolism, and electrical activity. It is interesting that they, too, have been particularly concerned with the effects of haemorrhage on hypothalamic blood flow and function. This part of the brain seems to be particularly susceptible to change as a result of injury to the body. Dr Kovach's work in this field should prove of increasing importance in our effort to understand the response of the body to injury. It is clear that we must no longer think of cerebral changes as arising solely from direct trauma.

The importance of adequate research into the prevention and treatment of head injuries is hard to overestimate, not only because of the vast amount of human suffering and chronic illness, but because of the vast costs involved. The cost to every country today of maintaining those crippled by damage to the brain caused by head injury is astronomical, and it is to be hoped that common sense will one day force the expenditure of adequate sums for the study of this terrifying problem of modern life. The whole subject is a major problem of the modern world.

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