column by a series of ligamentous and muscular bands. There is thus protection against the sun’s rays and a general mobility that provides for the avoidance of impending blows. But the cranium has chiefly to receive and annul transmitted physical vibrations, the result either of blows upon the head or of those jars and oscillations, incidental to bodily movements, which would interfere greatly with the functions of the brain did they actually reach it. The function of the cranium in this respect has been fully described by Hilton, who shows that special bony ridges are present in the skull which arrest vibrations and divert them into channels where their action is no longer deleterious. Three series of such buttresses descend from the vault to the base of the skull, where they converge in the region of the sella turcica at a point termed by Felizet "the centre of resistance, ” and where the terminations of the ridges come into immediate contact with the cartilage of the foramen lacerum medium or the lake of cerebro­spinal fluid which surrounds the anterior and posterior clinoid pro­cesses. The transmitted vibrations are thus annulled by transfer­ence to a liquid or a soft solid medium, and lose all further power. In addition to the special mechanism which mitigates the effect of considerable shocks and renders slight ones ordinarily imperceptible, there is a general elasticity of the skull which enables it to with­stand great violence without material injury and so enhances its protective power. This elasticity is not uniformly present, but is much more developed in the bell-like vault than in the region of the base. The osseous texture also is much more brittle in the latter locality. When, therefore, such severe shocks are communi­cated to the skull as overcome its elasticity and its power of resist­ance, the fracture which ensues is found as a rule to involve the base much more seriously than the vault.

These physical qualities are of great importance as giving an index of the relative resisting powers of different parts of the skull, and as affording data that may assist in determining the position of a fracture from a study of the forces which caused it. Of such forces those that are closely circumscribed in their area of appli­cation produce strictly local effects, whilst diffuse blows produce their most marked effects at a distance from their point of applica­tion. The former fact needs no illustration ; the latter has been made the subject of numerous researches in relation to the usual course of cranial fractures. From the results of these investigations three different etiological laws have been educed—(1) Saucerotte’s law of *contrecoup* ; (2) Aran’s law of radiation ; and, in special re­lation to fractures of the base of the skull, (3) Von Wahl's law of parallel cleavage. In its special sphere each of these laws probably holds true ; but the sphere of each is a limited one and is dependent upon the local peculiarities of the skull already described. The theory of contrecoup is that a force produces its maximum effect at the opposite pole of the skull to the point of its application. That this law can have no general bearing is shown by the numerous cases in which the fracture bears no such relation to the force which causes it. In relation to a limited area of the vault, however, it appears to hold true ; for isolated fractures of the base resulting from blows upon the vault are on record, but as these are the only fractures which this theory would explain, and as they are very rare, its range of action is very greatly curtailed. Aran’s law of radiation is that, starting from the point where the blow is received, a fissure traverses the walls of the skull in the direction of the base and spreads itself in that fossa of the base of the skull which corresponds to the part of the vault that is struck. Thus a diffuse blow on the frontal bone causes injury to the anterior fossa of the base, and blows upon the parietals or occipital bone cause similar injury to the middle or posterior fossa respectively. This law holds true of the great majority of fractures of the skull and will assist in localizing the course of a fracture when the part of the skull first struck can be recognized. But numerous cases of fractured base are on record in which no fissure can be traced leading from the point first struck ; and from a study of these Von Wahl has concluded that fractures of the base, whether connected with fissured vault or isolated, are always parallel to the direction of the force which caused them. Thus blows upon the frontal and occipital regions cause longi­tudinal fissures of the base, in the temporal region oblique fissures, and in the mastoid region transverse fissures. An index of the probable direction of a fracture is thus obtained by observing the exact point of incidence of the blow which caused it, whether other evidences of localized injury to the cranial contents be forthcoming or not.

The diagnosis of the presence of a fracture is often a matter of great difficulty, especially where the soft parts are still intact, and by their contused and swollen condition mask the true nature of the case. Apart from obvious external signs of injury, the following symptoms should lead to the suspicion of a fracture :—bleeding from the mouth, nose, or ears ; local ecchymoses or lacerations, as that of the membrana tympani ; circumscribed haemorrhages, as under the scalp or visceral conjunctiva ; interference with the func­tions of the brain or special sense-organs, as aphasia, motor spasms or paralyses, blindness, deafness, an altered condition of the respira­tion or the pupils, slight unconsciousness or profound stupor. The

immediate risks to life are from shock and compression, the latter due to depressed bony fragments or effused blood. The treatment of shock has already been alluded to (p. 680 above) ; that of com­pression consists in the early relief of pressure by trephining, with elevation of the depressed fragments and removal of the blood-clots, if the symptoms are advancing. These symptoms are increasing stupor, stertorous respiration (Cheyne-Stokes breathing), relaxation of sphincters,—the condition passing on to complete coma. In cases where pressure symptoms are not urgent (especially in young patients with elastic skulls) and in cases where no such symptoms are present, expectant treatment should be employed,—complete rest, local cooling applications, constantly applied, the exclusion of all stimuli to the special sense-organs or to the attention, and a careful watch for further symptoms. Should symptoms of compres­sion appear and advance, or should slight symptoms already present become aggravated, immediate operative interference for the relief of pressure as above indicated must be resorted to, and in operat­ing in this region it must be remembered that strict antiseptic pre­cautions are essential, for in no region of the body—not excluding even the peritoneal cavity—are the effects of septic infection more disastrous and at the same time so hopeless of remedy.

Having thus alluded to the physiology and surgery of the cranial envelope, it remains to consider the corresponding aspects of the cranial contents. The older theory of Flourens and Hertwig, that all parts of the brain are equally concerned in producing its aggregate activities, has been displaced by the more recent theory of the localization of function. This theory is supported by the results of recent physiological and pathological investigations, the former carried on for the most part by Hitzig, Fritsch, and Ferrier, the latter by Broca and Meynert. The practical outcome of these re­searches—viz., an adaptation to the human brain of results obtained in that of the higher mammals, controlled by pathological observa­tions on the human brain itself—is that the surface of the brain can be mapped out into a series of topographical areas, each of which occupies a definite relationship to some well-defined function- motor, sensory, or psychic—of the human economy. Of the areas connected with psychic activity little is at present known ; they are generally believed to occupy the frontal lobes of the brain. In the parietal region grouped around the fissure of Rolando are the cortical areas connected with motor functions in the extremities, and around the horizontal limb of the fissure of Sylvius are arranged those concerned in general and special sensation. The results of these researches confirm the views of Hughlings-Jackson, who has conclusively demonstrated the cortical origin of those epileptiform seizures in which the motor phenomena are limited to particular groups of muscles. At the same time these results open a new field of anatomical and surgical inquiry, with the object of defining what relation the cerebral convolutions bear to external cranial land­marks, and of showing that circumscribed cortical disease or injury is capable of detection and relief. For practical purposes in the present state of our knowledge of cerebral physiology, the first part of the question limits itself to an exact delineation of the position of the fissures of Rolando and Sylvius in relation to well- known cranial landmarks. In regard to the position of the former several researches have been made, and its upper extremity has been localized at a point 2 inches behind the coronal suture in the mesial line by Broca, Turner, and Féré. For the purpose of its exact determination in the living subject, where the line of the coronal suture cannot always be detected, measurements have been made and formulæ for its localization devised by Giacomini, Lucas- Championnière, Hare, and Reid (see the literature cited below). The commencement of the fissure of Sylvius is situated 11/4 inches behind the external angular process of the frontal bone.

As an outcome of these additions to our knowledge of accurate facts, a new branch of surgical procedure is now firmly established and already sufficiently supported by successful results, viz., trephin­ing for the relief of cortical disease. Encouraging cases have occurred in the hands of Hughes Bennett and Godlee, Fraser and Chiene, and Victor Horsley. The last-named presented to the British Medical Association meeting in 1886 three patients relieved by this operation from cortical lesions. As a result of wide ex­perience in operating upon apes and upon human beings, Mr Horsley accentuates the importance of employing the following precautions in operative interference :—(1) thorough cleansing and disinfection of the scalp ; (2) the use of chloroform as an anæsthetic, morphia having been previously given to reduce cerebral congestion and to obviate excessive hæmorrhage during the operation ; (3) strict antiseptic precautions ; (4) a semilunar incision through the soft parts; (δ) the use of large trephines; (6) Macewen’s method of replacing the bone in small fragments carefully purified. The occurrence of hernia cerebri signifies a failure in the antiseptic pre­cautions, and a primary union of the integuments is a matter of the most extreme importance. In removing the tumour or scar- tissue the knife is preferable to the thermo-cautery.@@1 (A. W. H.)

@@@1 *Literature of Cranial Surgery.—*Perceval Pott, *Injuries of the Head,* Sir Astley Cooper, *Lect. on Surgery* (Tyrell), vol. i. ; Sir B. Brodie, *Méd. Chir. Trans.,* vol.