THE DILATED PUPIL AND HEAD TRAUMA 1517–1867*

TODAY the significance of a dilated pupil in a patient following a head injury is well appreciated. Any physician called upon to examine an unconscious patient will include an inspection of the pupillary size, shape, and reaction in his examination. Standard neurology texts stress the importance of this observation in the proper evaluation of an unconscious patient.[26] In examining the historical writings about head injury, it is surprising that the occurrence, diagnostic implications, and mechanism of production of a third nerve palsy were not appreciated until the latter part of the nineteenth century.

This is even more surprising in view of the fact that injuries to the head were among the earliest topics written about in the medical literature. Several references to head injuries appear in the *Edwin Smith Papyrus*.[7] Here the important observation that weakness occurs contralateral to the side of the brain injury is made.

Among the Hippocratic writings is the first individual work devoted to head injuries.[20] *De Vulneribus Capitis* is a short work that is more important for the influence it had on surgical management of head injuries for the subsequent 2000 years than for the specific information contained in it. Although the writer was aware of certain neurological sequellae of head injuries such as contralateral hemiparesis and post-traumatic seizures, he did not use neurological criteria to determine the need for surgical intervention. Head wounds were classified according to the extent of the injury to the scalp and skull with little regard to what we today consider the neurological status of the patient. It was the type of fracture or injury to the skull that determined the need for trephination. The intricacies of this classification and the influence it had on later works are reviewed by Courville.[9]

Essentially, those wounds in which the calvarium was more or less intact—contusions, fractures of the outer table, and linear fractures—were trephined more often than depressed and comminuted fractures. Withington and Jones, in the introduction to their English translation, summarized this principle as: 'An injured skull should have a hole made in it if there is not one already'.[20] The Hippocratic writer was obviously not without practical experience. He pointed out that wounds of the skull in the region of the sutures often required trephination, and that the trephine should not be used across the sutures because of the risk of damaging the dura and its vessels. Nevertheless, we do not find indications for trephination that are based on the neurological signs and symptoms of the patient. It is this criterion—the neurological status of the patient—that is so important to us today. Only in the eighteenth century did this begin gradually to be appreciated by physicians caring for wounds of the head.

Even as the indications for trephination became better understood during the seventeenth and eighteenth centuries, we find no mention of the obvious sign of an enlarged and unreactive pupil associated with either an epidural or subdural hematoma. Many works of neurosurgical interest appeared in the sixteenth and seventeenth centuries; some of these were devoted specifically to head injuries or diseases of the

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brain.[5,6,32] Most of the works concerning head injuries were parts of general surgical texts or further commentaries on the Hippocratic work.[10,11,12,13,27] In none of these do we find any change in the basic concept that the nature of the skull wound determines the need for trephination.

Such works as those by Vidius[34] and Falloppius[13] are essentially commentaries on *De Vulneribus Capitis* with small additions by the authors. Even Paré patterned his discussion of wounds of the head after the Hippocratic text.[28] This work is particularly interesting because it is written in the vernacular and does constitute the observations of the outstanding practising surgeon of the sixteenth century.

Although his classification of head injuries is based on the types of fractures outlined in Hippocrates, the element of personal observation is readily apparent. The description of the injury of Henry II has often been cited as an early diagnosis of a subdural hematoma.[35] Paré proposes a mechanism for the production of a subdural hematoma. He mentions the possibility of a bridging cortical vein becoming torn and leading to the accumulation of a subdural hematoma. The symptoms of increased intracranial pressure—headache, blurred vision, emesis, decreased level of consciousness, and respiratory difficulties—are noted even though their mechanism of production is not understood. In view of the many opportunities Pare had to care for head injuries, it is all the more surprising that such a prominent finding as anisocoria is not mentioned. Throughout the sixteenth century writings we find no description or discussion of unequal pupils as a result of a head injury.

Herrlinger has recently emphasized the importance of including illustrations in medical books as part of the documented history of the medical practice of a period.[10] This is particularly appropriate with respect to the present topic. One of the most successful books on wounds in the sixteenth century—to judge by the large number of editions published—was Gersdorff's *Feldbuch der Wundartzney*.[16] This book has often been discussed because of the beauty of the woodcuts and because of the detailed presentation of surgical practices at the end of the fifteenth and beginning of the sixteenth centuries. The illustrations of surgical procedures such as the amputation of a leg, the treatment of a chest wound, and the elevation of depressed fractures of the skull have often been copied in later surgical works and reproduced in books on the history of surgery and medical illustration.[15,17,19,21] Even with the attention that the woodcuts have been given, one aspect of the two illustrations of elevation of depressed skull fractures seems not to have been given the careful attention it deserves. The first of these woodcuts (Figure 1), which Herrlinger reproduced in his book and described as 'an example of the finest woodcut graphic art of the early sixteenth century' depicts a method of elevating a depressed fracture in the temporal region. The woodcut on the following page (Figure 2) shows the use of a similar instrument, in this case a triploides, in a patient with a depressed fracture in the region of the bregma. The first woodcut has always been preferred by subsequent writers, either because the face of the patient is more appealing or perhaps because of the obliquity of the head which seems to create more tension and interest than the frontal view of the second patient. Both illustrations are good examples of sixteenth-century instruments for elevating depressed skull fractures and in this respect should be equally satisfactory to other authors. In any event the first woodcut is the one which appears

in works of the sixteenth, seventeenth, eighteenth and twentieth centuries.[17,19,21,27,31]

But what of the patients themselves? The striking difference between the faces of the two men would make one suspect that these are not just abstracted illustrations but rather portrayals by the artist of actual cases. All the more reason that we should look closely at the details presented. In the first woodcut there is more than a suggestion that the pupil ipsilateral to the depressed fracture is larger than the other one.* This is probably the first presentation of a third nerve paresis secondary to compression.

The second illustration is even more interesting with regard to the neurological findings. Here a patient with a depressed fracture in the right parasaggital area is shown; we see an inequality of the pupils which, while not as striking as in the first woodcut, is nevertheless apparent.† Even more important is the fact that the eye ipsilateral to the fracture is abducted, indicating further compromise of the third nerve function.

The artist, usually thought to be Hans Wächtlin of Basle, was more of a neurologist than Gersdorff and the subsequent authors who used his woodcuts. Not only did he portray the right third nerve weakness in the second patient, but there can be no doubt that he observed the weakness of the left side of the face which produced the marked facial assymmetry that he so strikingly depicted. Both of these woodcuts appeared in the many sixteenth-century editions of Gersdorff's book. They were also used in the first printed edition of Albucasis' surgery.[2] The first portrait, for whatever reason, was chosen by other authors for their own works on head injuries.

The other sixteenth-century source for later illustrations of neurosurgical procedures is della Croce's *Chirurgiae . . . libri septem.*[10] Although the influence of Gersdorff can be seen in many of the illustrations, those showing scenes of neurosurgical procedures, particularly those of the operating room itself, are quite original. The illustrations of elevation of depressed fractures again show the application of similar instruments to the head, but they are not direct copies of the woodcuts in Gersdorff. In della Croce's illustrations none of the neurological details seen in Gersdorff is depicted.

Gersdorff's first woodcut next appears in Paaw's *Succenturiatus Anatomicus* which is essentially Paaws' commentary on *De Vulneribus Capitis.*[27] Instead of a woodcut the illustration has been produced as an engraving with all the details faithfully copied including the difference in the size of the pupils (Figure 3).

The outstanding seventeenth-century work illustrating surgical practice is by Scultetus.[33] Here the illustrations of head wounds deal with types of incisions, trephination, and bandaging. They are reminiscent of Croce, but the elevation of a depressed fracture is not shown. The engravings are quite small, and no neurological details are shown. Several other surgical works of the seventeenth and early eighteenth centuries illustrate the treatment of head wounds, but none is detailed enough to be considered in the present discussion.[12,18] Certainly there is no mention in the texts of these works to indicate that the authors attached any significance to the examination of the pupils in patients with head injuries.

* In the 1551 edition available for measuring, the left pupil is 3 mm. in diameter and the right pupil is 2.5 mm. This difference was observed in all editions inspected—1517, 1528, 1530, 1540, 1551.

† The right pupil measures 3 mm. and the left pupil 2.5 mm.

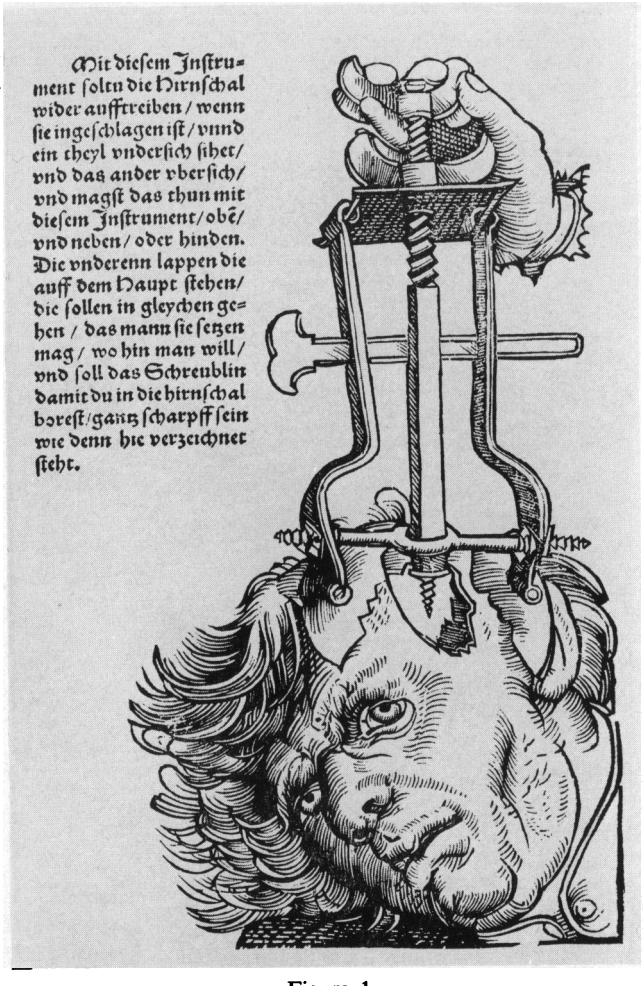

Figure 1
Elevation of a depressed fracture. Anisocoria is present. From Gersdorff, *Feldbuch der Wundartzney*, 1527[?].
By courtesy of The Wellcome Trustees.

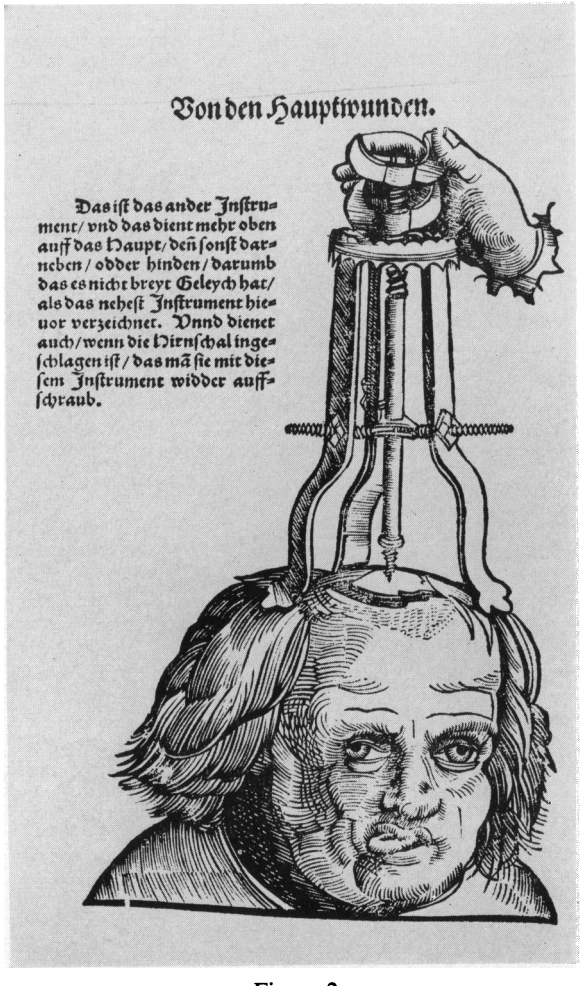

Figure 2
Elevation of a depressed fracture. The right pupil is enlarged, and the right eye is abducted. Left facial weakness is present. From Gersdorff, *Feldbuch der Wundartzney*, 1527[?].
By courtesy of The Wellcome Trustees.

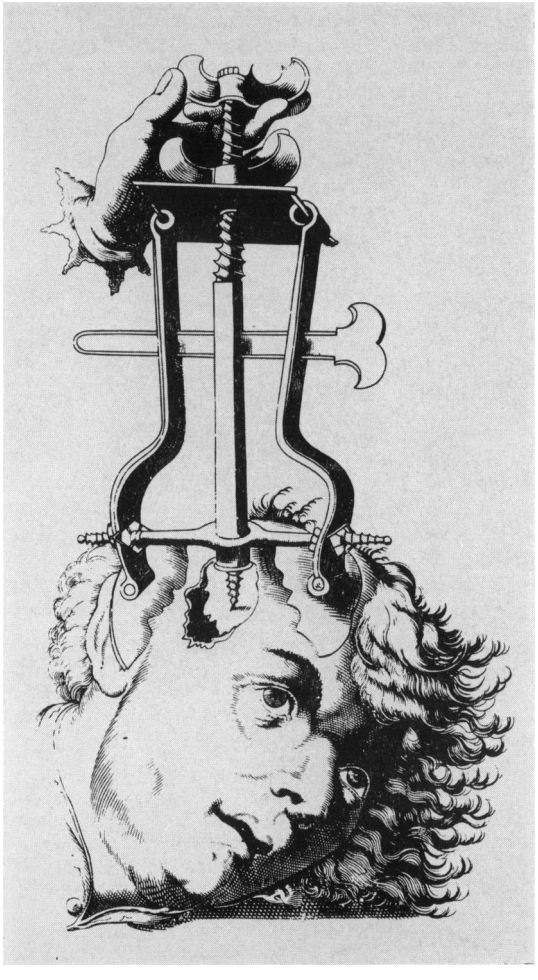

Figure 3

Elevation of a depressed fracture based on Gersdorff's illustration. Anisocoria is present. From Paaw, *Succenturiatus Anatomicus*, 1616.
By courtesy of The Wellcome Trustees

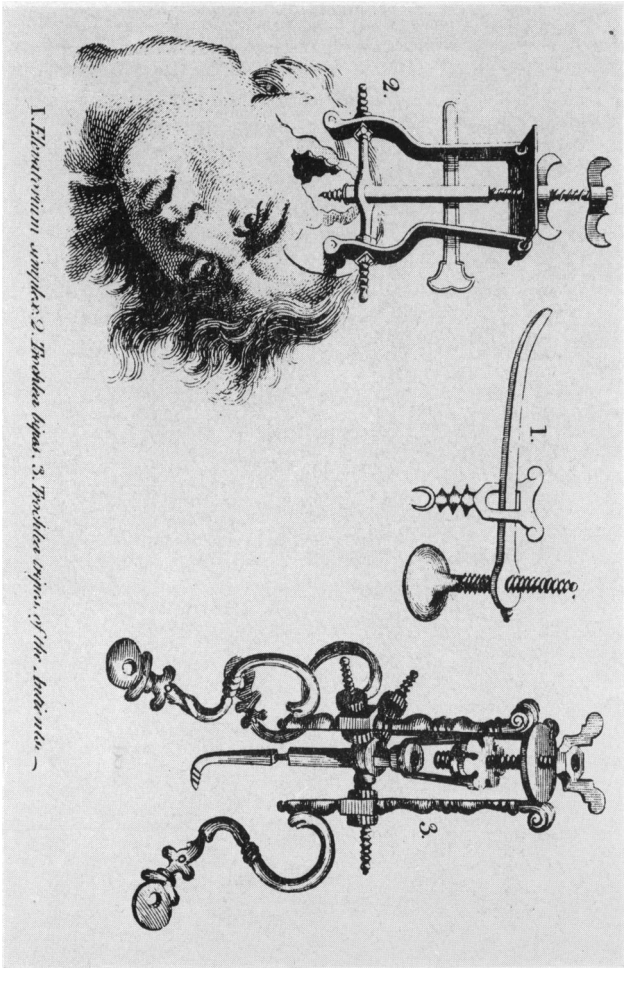

Figure 4

Elevation of a depressed skull fracture based on Gersdorff's and Paaw's illustrations. From Pott, *Observations on the nature and consequences of those injuries to the head . . .*, 1771.
By courtesy of The Wellcome Trustees.

In 1751 Robert Whytt published *An Essay on the Vital and Other Involuntary Motions of Animals.*[36] In Section VII he discusses the pupillary reaction to light and cites several cases in which the size and reactivity of the pupils varied. He does not mention anisocoria or alteration of pupillary reaction in association with a head injury. This interest in pupillary function failed to produce any commentary on its relation to head injury during the eighteenth and well into the nineteenth century.

Even Percivall Pott failed to make note of the pupillary reaction in head injuries.[30,31] In the second edition of his book on this subject we again encounter the Gersdorff illustration, but there is no mention of the anisocoria shown in either Gersdorff or Paaw.[31] The engraving in Pott's book shows both pupils equal in size (Figure 4). Pott's book is of interest in that he calls attention to and accepts Le Dran's observations on head injury. The French surgeon was the first to point out the significance of the lucid interval following a period of unconsciousness produced by an injury to the head.[25] In 1731 he wrote that the immediate loss of consciousness following a head injury is due to concussion and that unconsciousness that again appeared later, after the patient had become alert, was indicative of compression of the brain by a blood clot. This he felt was a strong indication for trephination. Another French surgeon J.-L. Petit stressed the importance of the lucid interval as a criterion for distinguishing concussion from compression.[29]

Here is the beginning of the modern evaluation of patients with head injuries; the basis of surgical intervention is now the neurological status of the patient rather than the local appearance of the wound. A few years later Benjamin Bell wrote the end to the Hippocratic classification of head injuries that had been the major influence for 2,000 years.[14] 'It is the effect which fractures of the skull and other injuries produce upon the brain which we ought to consider and not their external appearances.'[23] He gave credit to Le Dran and Pott for first making this important distinction.

During the early years of the nineteenth century many writers described adequately the pathological sequellae of head injuries—subdural and epidural hematomas, laceration of the brain, and suppuration as a later consequence.[1,4,22] All of these lesions are capable of producing compression of the brain and the common symptoms and signs of increased intracranial pressure; yet until well into the nineteenth century no writer commented on the occurrence of anisocoria in association with a mass lesion. Certainly no one made the association with compression of the third nerve.

In his famous and magnificently illustrated case reports, Richard Bright observed a dilated pupil in a man who at autopsy was found to have an epidural hematoma on the same side as the dilated pupil (Case CXCI).[8] He noted that the pupil became dilated on the second day after the head injury when the patient was noted to be less responsive and to have a slow pulse.

Although the artist Hans Wächtlin had observed the eye signs associated with compression of the third nerve in two patients with depressed fractures, no medical writer made this observation for the next 300 years. This cannot be attributed to either lack of interest in head injuries nor to failure to appreciate the merit of Wächtlin's woodcuts.

It remained for Jonathan Hutchinson to establish the significance of a dilated pupil

following an injury to the head. In 1867 he reported his experience with head injuries and his observations of a dilated pupil on the side of an intracranial clot.[23] He also made the clinical-pathological correlation in two cases to explain the mechanism of the dilated pupil, '. . . from the position of the clot there can be little doubt that the third nerve is compressed and thus, the dilatation of the pupil is explained. These two cases, so exactly parallel, seem to supply us with a new and very valuable symptom indicative of effusion of blood in this situation.'[23]

That this phenomenon should be referred to as a 'Hutchinson pupil' is, as Jacobson suggested in 1886,[24] amply justified after we have considered the historical writings and illustrations of injuries to the head. This is further emphasized in Hutchinson's own modest and succinct summary. ' . . . nor can we perhaps boast of having learnt much which may aid us in the diagnosis of future cases with the one exception of having discovered the meaning of the one dilated pupil. This point we will store up carefully for future use.'[23]

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Dr. G. B. Risse has been recently appointed Associate Professor and Chairman of this Department. He succeeds Dr. Nikolaus Mani who accepted the chair of medical history in Bonn, Germany. Dr. Risse is a native of Argentina where he received his M.D. degree in 1958. After coming to the U.S. for graduate medical training, he received his Ph.D. degree from the Department of History, University of Chicago, in early 1971.

SWISS SOCIETY OF THE HISTORY OF MEDICINE AND NATURAL SCIENCES

This Society celebrated the fiftieth anniversary of its foundation on 9 October 1971 in Fribourg, Switzerland. In the course of a symposium dedicated to the history of scientific exchanges between Switzerland and other countries, E. H. Ackerknecht delivered the Guggenheim Lecture on *Swiss-American medical relations*. The other speakers were L. Belloni (Italy), S. Gilder (Great Britain), E. Lesky (Austria), G. Rudolph (Germany) and J. Théodoridès (France). At the same meeting the Henry E. Sigerist Prize was awarded to Ursula Bück-Rich, M.D., Zurich, and to Fritz Kubli, Ph.D., Zurich.

The Society conferred honorary membership upon Mrs. E. Guggenheim-Schnurr, Basle, and Prof. E. H. Ackerknecht, M.D., Zurich. Prof. H. Buess, M.D., Basle, was elected as president in succession to Prof. Ackerknecht, who had been an active and most successful president for ten years. The secretary is now: Prof. H. M. Koelbing, Medizinhistorisches Institut der Universität Zürich, Rämistrasse 71, CH-8006 Zürich.