Hippocrates' influence on the origins of neurosurgery

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✓Hippocrates is widely considered the father of medicine. His contributions revolutionized the practice of medicine and laid the foundation for modern-day neurosurgery. He inspired several generations to follow his vision, by pioneering the rigorous clinical evaluation of cranial and spinal disorders and combining this approach with a humanistic and ethical perspective focused on the individuality of the patient. His legacy has forever shaped the field of medicine and his cumulative works on head injuries and spinal deformities led to the basic understanding of many of the fundamental neurosurgical principles in use today. (DOI: 10.3171/FOC-07/07/E9)

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AMONG MEDICINE'S MOST CELEBRATED PROGENY, no one has left a legacy as prolific and long-lived as Hippocrates. Largely hailed as the father of medicine, Hippocrates of Kos (460–377 BC), an ancient Greek physician and teacher, was the first to separate medicine from divine forces, using observations and inductive reasoning instead of theology and philosophy to guide clinical practice.^{6,8,9} These observations, many of which hold true today, laid the groundwork for numerous modern-day medical specialties, establishing Hippocrates as a true pioneer. He is the author of at least 70 works covering almost all fields of medicine, only 60 of which have been preserved following the fire that destroyed the great library of Alexandria at the end of the second century. The salvaged works were collected and published under the title *Corpus Hippocraticum*, a compilation of the Hippocratic medical principles and ethical concepts that have guided the medical community for centuries.⁶ Hippocrates traveled throughout Greece practicing his medical concepts. He founded a medical school on the island of Kos, Greece, and began teaching his ideas. He developed an oath of medical ethics, which is now followed by all physicians in their medical practice.²

On Wounds of the Head: Cranial Anatomy

Hippocrates was well known for his comprehensive clinical evaluations that integrated observation, diagnosis, prognosis, and treatment. He authored numerous texts on head injuries and surgeries, which included descriptions detailing different neurological conditions and brain diseases. The treatise *On Injuries of the Head* is one of his

works that truly sets the stage for modern-day neurosurgery.^{1,7}

Hippocrates begins this treatise with a thorough examination of cranial anatomy, addressing issues such as cranial configuration, structure, thickness, shape, and sutures. For example, he describes the different osseous layers making up the cranium, noting durability as well as areas where the layers become thicker or thinner. Later in the treatise he also notes differences in the texture and softness of the cranial bone between adults and children. This impressive level of detail reveals how Hippocrates was a physician well ahead of his time.

He then describes six specific types of cranial trauma—fissured fractures, contusions without fracture; depressed fractures; “hedra,” or dented fractures; cranial lesions distant from the scalp wound (contrecoup fractures); and wounds above cranial sutures.

A fissured fracture occurs where a weapon breaks the bone, resulting in a fracture and contusion. Hippocrates recognized that this type of trauma comes in many varieties. Some fracture lines can be fine, whereas others are thick and wide. They may be short or long, restricted to the superficial osseous layers, or cutting through the depths of the entire bone. Hippocrates' experience in treating head injuries is evident when he highlights the fact that the latter type of fracture can be “so very fine that they cannot be discovered, either immediately after the injury, or during the period in which it would be of use to the patient.”¹ In fact, there have been many cases in which patients with these types of injuries have died from distal bone lesions, despite the lack of visual damage at the site of injury.

Contusions without fractures occur when the bone does

not break and is kept in place after an injury. These injuries also vary with parameters similar to those for fissure fractures in terms of length, depth, and degree of severity. In his teachings, Hippocrates emphasized that this type of trauma can be very difficult to diagnose immediately following injury as “none of these forms [are distinguishable] by the eye as to its precise shape and size.”¹

The third type of cranial injury described—depressed fractures—occurs when a fracture results from a bone being pushed inward. About this type of injury, Hippocrates states that the “depression may comprehend a greater and a smaller extent of bone, and may either be to a greater depth, or less so and more superficial.”¹

Hedra means “dent of a weapon” in Greek, and this type of trauma refers to “when the bone keeping its natural position, the weapon sticks into it and makes a mark where it stuck.”¹ Hippocrates notes that dented fractures from weapon blows are also “necessarily [accompanied by] more or less contusion.” Dented fractures “may be longer and shorter, crooked, straight and circular . . . according to the shape of the weapon” used and “may vary in depth and narrowness” as well. To clarify the differences between what constitutes a dented as opposed to a depressed fracture, Hippocrates states that a hedra occurs “if the rest of the bone round the cleft keeps its natural place and is not crushed in by the cleft.” If the latter were to occur, then the resulting injury would “be a contused depressed fracture, and no longer a hedra.”

Cranial lesions distant from the scalp wound, or contrecoup fractures, are said to occur when the cranium “is injured in a different part of the head from that on which the person has received the wound.” According to Hippocrates, this type of trauma is the most difficult to treat, given that “there is no possible way of examining” the patient and “when this accident occurs, you can do nothing to help.”

Finally, Hippocrates describes wounds above cranial sutures. He states that areas surrounding sutures are particularly sensitive to injury due to their porous construction. For this reason, “a person wounded by weapons of equal, similar or much less size to a similar or much less extent suffers far greater mischief in his skull, if he receives the weapon at the sutures.”

On Wounds of the Head: Clinical Evaluation, Treatment, and Prognosis

Perhaps as a tribute to observation, Hippocratic medicine emphasizes the clinical evaluation of a patient, which includes understanding a patient’s medical history, observing and inspecting the wound, and palpating the wound to determine a proper treatment. The inherent value in this type of Hippocratic methodology is clear to today’s medical community, and although this approach constitutes standard procedure today, the fact that Hippocrates put this method in place more than 2000 years ago is rather remarkable.

In a patient with a head injury, Hippocrates determined that such an injury could occur in three ways: 1) “wounded by another;” 2) “wounded about the skull or in the skull itself by falling;” and 3) a “missile weapon” hitting any part of the cranium. The exact mechanism of injury was considered to be a major part of a patient’s clinical evaluation

given that different types of lesions are associated with certain mechanisms and weapons. Hippocrates noted that these weapons could come in two types: “rounded, smooth surfaced, blunt, heavy and hard” or “elongated, slender, sharp, and light.” The former type of weapon tends to produce fissured, contused, and depressed fractures, whereas the latter type generally “do not produce contusions, nor fractures, nor depressions inwardly,” although a hedra could on occasion be produced.

Hippocrates often advised his followers that the first issue to address when presented with a patient who has sustained a head injury was locating the wound and determining whether the cranium underneath was strong or weak. How the patient’s hair was arranged also provided clues; the presence of hair in the wound was a strong indication for injury to the bone. However, he noted that the initial inspection should be conducted before palpation. The purpose of palpation was then to determine “whether the bone is denuded of flesh or not.” If the bone was not directly visible, Hippocrates used a “probe” or “sound,” which helps the physician to locate the weapon mark.

Hippocrates devoted a significant portion of the latter part of his treatise to descriptions of treatment methods for the various cranial traumas that were detailed earlier. Regarding first aid and bandaging, Hippocrates stated that “a lesion in the head should not be moistened with anything, not even wine . . . nor should the treatment include plasters or plugging” unless an incision is required. Furthermore, bandaging should be reserved only for lesions “on the forehead, in the part which is bare of hairs or about the eyebrow and eye until inflammation ceases and swelling subsides.” Bandages were also applied to wounds in the frontal and orbital areas of the head, which could be explained by the belief that blood circulated from the head and flowed from the upper regions of the body to the lower regions. Given that the frontal and orbital regions lie at a lower level compared with the parietal regions, these areas were considered to be more prone to inflammation.

Hippocrates recommended incisions into the wound under only two circumstances, that is, when the bone is denuded and the likelihood of injury is almost certain and when the wound is not large enough to allow direct visualization of the bone. He advised that “incisions may be safely made in any other part of the head but the temple, or the part above it in the region traversed by the temporal blood-vessel, for spasm seizes the patient.” His reasoning was based on the misconception that when the superficial temporal artery is cut, spasms could be produced contralaterally, which he interpreted as a poor prognostic factor. For cases in which the cranium is denuded of skin, he recommended separating the skin from the bone and plugging the wound with lint for 24 hours to prevent wound closure and collapse. On removal of the plug, the physician could then explore the wound to determine the type of fracture and take the necessary action, which, he said, should be done within 3 days from the time of injury.

For extremely severe cranial injuries that do not fit into any of the aforementioned trauma categories, Hippocrates developed a rather clever approach to determine the nature of the wound. The physician applied a black solution to the wound with a linen rag and then inspected and cleaned the wound the following day. The wound, “having im-

bibed the solution will appear black, while the rest of the bone is white." If the bone remained black after scraping, trephination was recommended. Hippocrates also recommended trephination for fissured, contused, and dented fractures with contusion or for contusion alone. The theory behind this procedure was the creation of an opening for the excess blood and cerebrospinal fluid that collected underneath.

Hippocrates was also believed to be the first physician to attempt and document the treatment of hydrocephalus. In fact, he may have been the first to perform ventricular punctures, although this point is controversial given that some consider he was only draining the subdural or sub-arachnoid space.¹

Hippocrates' vast experiences in treating neurological patients also allowed him to develop a system of prognostic factors. For Hippocrates, prognosis was an important part of medical treatment because by forecasting disease outcome, the physician was established as the appropriate expert for treating the patient. Generally, Hippocrates found that "the lesions [at the bregma] are more mortal, medical treatment and escape from death more difficult here than any other part of the head," whereas patients sustaining blows to the posterior cranial portions have a more favorable outcome. Brain abscess and bone suppuration indicated bleak prognoses, whereas posterior and occipital blows generally held a more favorable course.

Contributions to Spine Surgery

When one considers that Hippocrates lived during a time when dissections of the human body were unacceptable, even forbidden, it is amazing to note the amount of detail and information that he collected through observations and documentation of different case studies. Although emphasis thus far has been placed on his influences in the evaluation and treatment of cranial injuries, Hippocrates also made major contributions to the field of spinal surgery. Together with Galen (AD 129–circa 216), the second most famous ancient Greek physician, their impact on this field is unquestionable.¹⁰

Although it was Galen who established better spinal treatment approaches—likely due to his more accurate models of the vertebral column and spinal cord anatomy⁵—Hippocrates set the foundation for much of Galen's work. In his treatise *On Joints*, Hippocrates describes methods for the management of spinal diseases. He deals mostly with the correction of curvatures of the spine and spinal injuries.⁴ For the treatment of spinal deformities, he developed the Hippocratic table, a support used to help correct the placement of vertebrae that moved backward. The patient was strapped onto the table, allowing the trained physician to apply pressure to the deformity by using his hands or feet or even by sitting. The Hippocratic table is actually still in use today: many consider it to be the prototypical ancestor of modern orthopedic tables. In his papers Hippocrates also described many other treatment methods for all types of deformities, which even included the controlled shaking of a patient hung from a ladder. This shaking was believed to help reduce the level of deformity, although Hippocrates himself seemed skeptical of this method.⁴

Understanding Brain Function and Epilepsy

Hippocrates had a thorough understanding of the human body and, in particular, the brain. He believed that the body must be treated as a whole and not just a series of parts. He was the first physician to assert that thoughts, ideas, and feelings come from the brain and not the heart as others of his time believed. He recognized that the brain was involved in sensation and was the center of intelligence.

He accurately described disease symptoms and was the first physician to accurately note the symptoms of epilepsy in children. He wrote the first book on epilepsy, *On the Sacred Disease*.¹¹ Refuting the idea that epilepsy is a curse or a prophetic power, as was previously believed, Hippocrates states that it's a brain disorder. "It is thus with regard to the disease called Sacred: it appears to me to be nowise more divine nor more sacred than other diseases, but has a natural cause like other affections."¹¹

Conclusions

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References

1. Adams F (trans): **The Genuine Works of Hippocrates, vols 1 and 2.** New York: W Wood & Co., 1886
2. Lifshutz JJ, Johnson WD: History of hydrocephalus and its treatments. **Neurosurg Focus** 11(2):E1, 2001
3. Marketos SG, Diamandopoulos AA, Bartsocas CS, Poulakou-Rebelakou E, Koutras DA: The Hippocratic Oath. **Lancet** 347: 101–102, 1996
4. Marketos SG, Skiadas P: Hippocrates. The father of spine surgery. **Spine** 24:1381–1387, 1999
5. Marketos SG, Skiadas PK: Galen: a pioneer of spine research. **Spine** 24:2358–2362, 1999
6. Marketos SG, Skiadas PK: The modern hippocratic tradition. Some messages for contemporary medicine. **Spine** 24: 1159–1163, 1999
7. Panourias IG, Skiadas PK, Sakas DE, Marketos SG: Hippocrates: a pioneer in the treatment of head injuries. **Neurosurgery** 57: 181–189, 2005
8. Poulakou-Rebelakou E, Marketos SG: Renal terminology from the Corpus Hippocraticum. **Am J Nephrol** 22:146–151, 2002
9. Viale GL, Deseri S, Gennaro S, Schrbundt E: A craniocerebral infectious disease: case report on the traces of Hippocrates. **Neurosurgery** 50:1376–1379, 2002
10. Xarchas KC, Bourandas J: Injuries and diseases of the spine in the ancient times. **Spine** 28:1481–1484, 2003
11. Zanchin G: Considerations on "the sacred disease" by Hippocrates. **J Hist Neurosci** 1:91–95, 1992

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