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Galen and neurosurgical procedures

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Abstract. There are two areas where Galen's competence with neurosurgical procedures is documented. The first is his clinical work described in the *De methodo medendi* (*Method of Medicine*). He states that his writing is merely an extension and perhaps a clarification of the writings of Hippocrates. His comments on the various instruments and their correct use would seem to be characteristic of any competent and concerned surgeon.

The second area is his experiments. They included both dissection and vivisection of animals. He described a big vein in the depth of the brain, which was named after him (the vein of Galen) and pineal gland (he coined its name). He considered that the latter was involved in the movement of the psychic pneuma from the lateral ventricles to the ventricle in cerebellum. In a famous book by Thomas Willis pineal gland is shown as spherical, that might be a result of its distortion during dissection. Thanks to his superb technique Galen could also follow the course of the recurrent laryngeal nerve. He operated on pigs and goats rather than apes for sentimental reasons. His experimental surgery included compression and then incision on cerebral ventricles. Some animals survived after operations which were performed without effective means of brain haemostasis, suction and modern illumination. This would seem to indicate he must have operated without intradural haemorrhage and also an ability to retain vision and maybe even retract the brain without doing irreversible damage.

All this would suggest that while Galen would not have been a neurosurgeon in the modern sense of the word there is good reason to believe he had a neurosurgical technique which would be acceptable even today.

Keywords: Galen, surgical technique, dissection, experimentation, neurosurgery

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Introduction

Was Galen a competent neurosurgeon? This apparently simple question is not susceptible of a simple answer, since there are different opinions about what constitutes a neurosurgeon. Eugene Flamm in a paper entitled "Percival Pott: an 18th century neurosurgeon" states, "His books on head injury and the two works on disease of the spine make it quite appropriate to consider Pott as an 18th century neurosurgeon, long before the specialty came to be recognized" [1]. Boleslav Lichterman takes a totally opposite view. He states, "The period of the first brain surgery procedures and the emergence of surgeons who specialized in such interventions cannot be considered to be the period of the establishment of a new discipline" [2]. These two views are mutually incompatible and following discussion with colleagues apparently irreconcilable. It follows that a middle way must be found if the subject is to be acceptable to all parties. It is suggested that one accepts that calling someone a neurosurgeon is not the heart of the issue. The core point is whether a given individual has in the course of whatever practice shown expertise in the use of neurosurgical techniques. This is put forward as the basis for the discussion of Galen's talents.

Galen's writings related to neurosurgical technique are taken from his Method of Medicine and the De usu partium [3, 4]. Other commentary texts have been used for background information and context. The findings presented are interpreted through the filter of over forty years of neurosurgical experience.

Galen's background is lucidly outlined by R.J. Hankinson in the Cambridge Companion to Galen [5]. He was born into a good family in September 129 AD, in the large and prosperous city of Pergamum. This city was reputed to possess the best library

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outside of Alexandria. His father Nicon was an architect[1]. Galen was close to his father but not his mother, who had the reputation of a filthy temper and who was not above biting her servants. This may be a reason why Galen never married. While he relates to women he does not seem for the most part to have valued them highly. Nicon stimulated Galen to study grammar, mathematics, logic, and philosophy. The rumor goes that he was aiming to be a philosopher when his father had a dream which decided Galen should study medicine. After his extensive education, he returned to Pergamum and was appointed as a surgeon to the gladiators. This would have given him wide orthopedic experience and would have extended his knowledge of superficial anatomy. He travelled to Rome where he worked from 162 to 166 AD. He returned to Pergamum for unclear reasons and was summoned back to Rome by the Emperor Marcus Aurelius [5].

He wrote an enormous amount of writings which cover the whole of medicine (or rather he dictated to relays of slaves) [5]. For our present purpose, attention shall be limited to texts concerned only with operations on the head. This will be considered with respect to the clinic and the laboratory.

Clinical Neurosurgery

Operations on the head from the ancient world up to the late 19th century were limited to the management of cranial trauma. Galen was no exception. He describes his principles and indications in *Method of Medicine, Volume VI, Chapter 6*. He starts out by stating that Hippocrates has written a comprehensive treatise on skull fractures. He continues that he will only mention discoveries not included in Hippocrates monograph. These discoveries include a superior classification of fractures, the description of different instruments not mentioned by Hippocrates and the preferred method of opening the cranium [3]. Like Hippocrates, his attention is directed towards the skull and there is no mention of surgery directed at the brain itself.

He classifies fractures as follows, which is close to a modern classification:

Extending to the diploe;

Extending to the internal surface;

Simple;

Comminuted;

Depressed.

In the absence of X-rays, he perceives a need to define a fracture and advocates using a variety of scraping instruments to scrape the bone into the depths. He mentions raspatories, cyclisci, a lenticulus and hammer and trephines. The raspatories are thought to have had a straight edge and the cyclisci a curved edge and cross-section. Like any surgeon, he insists that there should be a variety of instruments and for each instrument a variety of sizes.

He then specifies how to manage fractures with crushed bone, which he believes needs to be removed. He describes four instruments to be used in this case. Firstly, there are two kinds of trephine, one which can plunge in and one which cannot. He mentions also the cyclisci in this context. The nature of cyclisci is s defined in *Chamber's Cyclopaedia, or An Universal Dictionary of Arts and Science, Volume 1,* in 1728 as "An Instrument in a form of an half moon; used by surgeons to scrape away rottenness" [6].

He demonstrates care for the safety and comfort of the patient when he expresses a dislike for both trephines and cyclisci for opening the cranium. He states the trephines are dangerous since they can plunge in and the cyclisci shakes the head too much. He prefers using the lenticulus. The use requires the creation of an opening in the skull into which the lenticulus may be inserted. Such an opening may be the result of the fracture or may be produced with either a cycliscus or a trepan. Galen emphasizes the safety of the lenticulus with respect to protection of the dura. He states, "The thick membrane cannot, in fact, be injured even if the person operating is half asleep"[3]. This remark is so typical of a surgeon confident in his own technique.

Galen also gives instruction on bandaging and ointments which lie outside the scope of this paper. Suffice it to say his clinical neurosurgery was limited to cranial trauma and his management was from his point of view, in the absence of images logical and directed towards comfort and safety.

Laboratory Neurosurgery

Dissection

Another area where Galen would need to apply neurosurgical techniques was in his operations on

[1] An architect would have also meant an engineer.

experimental animals. Much of his work relating to structure and function was presumably carried out on dead animals though operative details do not survive. He had, however, a very thorough knowledge of cerebral anatomy extending deep into the brain. The vein of Galen is as deep and central a structure as is possible to imagine. He also knew and named the pineal gland [8]. He knew the corpus callosum, the pituitary and the fornices. He also gave a detailed description of the ventricular system which includes the lateral (anterior) ventricles and third ventricle located in the softer cerebrum. He describes the fourth ventricle [8] located in the harder parencephalis, or cerebellum. He considered that the pineal gland was involved in the movement of the psychic pneuma created in the anterior ventricles facilitating its passage to the ventricle in the cerebellum. However, the passage through which this pneuma is moved is not the Aqueduct of Sylvius but some notional passage including the subarachnoid space above the midbrain [4]. The nature of this pneuma is not specified in modern terms, but it is not cerebrospinal fluid (CSF).

For Galen, to have acquired the anatomical knowledge of which he demonstrated familiarity could only have been obtained by detailed dissection. This would for the structures outlined above have involved the dissection of dead brains, since dissecting these structures in living animals is not compatible with survival. Over and above his dissection of the brain he followed the courses of the branches of the various cranial nerves including the course of the recurrent laryngeal nerve from the brain stem to the larynx. This must have been an exercise in superb technique.

Vivisection

While Galen acquired a thorough knowledge of the macroscopic anatomy of the brain and cranial nerves through the dissection of animals, this of itself does not bespeak advanced neurosurgical technique; just industry and thoroughness. There were, however, a series of operations on living animals to investigate the function of the cerebral ventricles which required living subjects. In view of his reputation for being a combative and less than a sympathetic person, there is a comment he made in this context, which again, like his technique for opening the cranium

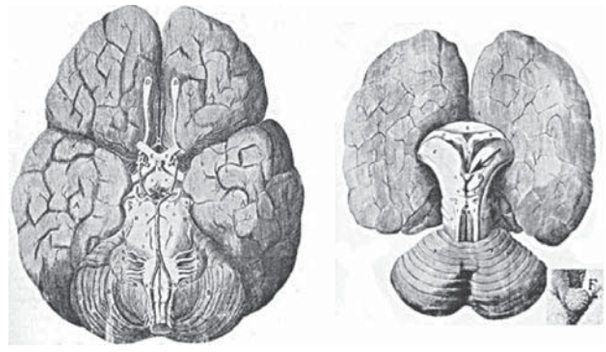

Figure 1. The image on the left is has been described as the most famous 17th century brain illustration. Its illustrious creators speak for the quality. The image on the right confirms Steno's remark that Willis was responsible for the best illustrations of the brain; but not without error [13]. The pineal gland is indicated with a black arrow and an enlargement of that part of the image shows that the pineal gland is indeed spherical.

mentioned above, speaks to his humanity. Lloyd records that Galen recommended using a pig or a goat for an operation in which the brain is exposed in the living animal in part to "*avoid seeing the unpleasing expression of the ape when it is being vivisected*" [9].

One of the most impressive pieces of research Galen undertook was the effect of first pressure and then incision on different parts of the ventricle system [10]. The details of the technique remain obscure. Did he make a wide craniotomy/ectomy enabling access to all ventricles in one animal or did he make separate operations to access the different components of the ventricles? We do not know. At all events he noted changes in level of consciousness, which he recorded as stupor following pressure to the anterior, intermediate (third) and posterior (fourth) ventricles. The stupor was more profound the more posteriorly the pressure was applied. The same was the case with incisions into the ventricles [10]. The crucial point in terms of surgical technique is that some of the animals returned to normal following the experiments [10].

In these experiments with surviving animals, it is implied that the handling of the skin was adequate to control scalp haemorrhage. This could have been done by the means that were available which were pressure, styptics, ligature and cautery [11]. These techniques could not be used on the brain, especially in the small animals

involved. Thus, he would have been more or less obliged to operate within the dura without causing hemorrhage. Moreover, as he pressed on and incised the fourth ventricle parts of the brain would have had to have been retracted to gain access. This would have required instruments of which we do not know and it would also have involved delicacy of touch. In respect of incising the fourth ventricle and achieving a surviving animal, these incidents need a further consideration. His only source of illumination was the sun or, perhaps, candlelight. The approach to the fourth ventricle that he used is not known, but it would have involved retraction and elevation of these inaccessible structures – since there is no line of sight from the surface to the fourth ventricle in the normal brain. To do this in a small animal with the available technology and then incise the fourth ventricle and even so achieve survival bespeaks a considerable degree of competence in those techniques which a neurosurgeon needs to master.

A further indication of delicacy of touch is shown by his describing the pineal gland as shaped like a pine cone giving rise to its name. This is impressive because of the experience of Niels Stensen (Nicolas Steno) (1638–1686), who wrote as follows over a millennium later: "*Dissections or preparations being liable to so many mistakes, and anatomists having hitherto too readily formed systems, and molded these soft parts in the manner that was most agreeable to each, we cannot be surprised to find so little exactness in their figures. But this want of accuracy in the figures is not owing to bad dissections only. The ignorance of drawers has contributed very much, and the difficulty of expressing the several eminences and depressions of the parts, and of understanding what the anatomists chiefly insist upon, furnishes them with a never failing excuse*" [12]. Steno draws attention to the Thomas Willis' (1621–1675) brain illustrations as the best, however they were not without error [13, p. 271]. In figure 1, the image on the left illustrates the quality of such illustrations drawn by Sir Christopher Wren (1632–1723). On the other hand, the figure on the right shows the relevant error which is that Willis and Wren drew the pineal body as spherical. This could well be the result of distortion of the pineal during presentation as indicated above. Thus, in the 17th century, even the most accomplished medical dissectors and illustrators could distort the small pineal gland. The fact that Galen described it as pine cone shaped and not spherical that indicates a lack of distortion the result of superior surgical technique.

Conclusions

The data simply does not permit any certain conclusions about Galen's neurosurgical technique yet the following tentative conclusions may be made.

His classification of fractures was sensible and his surgical approach to them – practical and logical;

His surgical technique considered all the available methods and recommended the one which provided the least discomfort and the greatest safety;

His physiological experiments could not have achieved the results we know unless his neurosurgical technique had been immaculate.

While he might not have been a neurosurgeon in so far as he was not engaged full time in that specialty there are plentiful indications that he operated inside the cranium with the delicacy and precision which successful neurosurgery requires.

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