

Egypt Exploration Society

The Problem of Brain Removal during Embalming by the Ancient Egyptians

Author(s): F. Filce Leek

Source: *The Journal of Egyptian Archaeology*, Vol. 55 (Aug., 1969), pp. 112-116

Published by: [Egypt Exploration Society](#)

Stable URL: <http://www.jstor.org/stable/3856007>

Accessed: 05/01/2015 12:32

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at
<http://www.jstor.org/page/info/about/policies/terms.jsp>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



Egypt Exploration Society is collaborating with JSTOR to digitize, preserve and extend access to *The Journal of Egyptian Archaeology*.

<http://www.jstor.org>

THE PROBLEM OF BRAIN REMOVAL DURING EMBALMING BY THE ANCIENT EGYPTIANS

By F. FILCE LEEK

UNTIL the appearance in 1911 of Karl Sudhoff's essay 'Ägyptische Mumienmacher-Instrumente',¹ medical historians had formulated no views on the removal of the brain during the embalming process other than that expressed by Herodotus in the fifth century B.C. He wrote: 'First they (the embalmers) drew out the brain through the nostrils with an iron hook, taking part of it out this way, and the rest by pouring in drugs.'²

In an attempt to gain further knowledge of this subject the author examined skulls of ancient Egyptians in the Macalister Collection at Cambridge³ made by Sir E. A. Wallis Budge whilst he was in Egypt, and believed by him to consist of skulls of priests of the third and fourth degrees who served in the temples at Aswân.⁴ Investigation of the late Professor Alexander Macalister's papers revealed that originally there were some 500 skulls in the collection.⁵ Of these, 56 per cent showed a hole, made *post mortem*, in the base of the skull through the cribriform plate of the ethmoid bone. In 5 per cent it had been made through the left nostril, and in 3 per cent through the right one. In others the nasal septum had been wholly or partially removed, so that a much larger perforation into the base of the skull had resulted. Mainly owing to damage suffered in the Second World War the number of skulls has unfortunately been reduced to 327; of these, 22 were not in a condition to permit assessment. It was established that in 11 per cent the extracting instrument had been introduced through the left nostril to make an entrance into the base of the skull, and in 5 per cent its course had been through the right nostril. In 62 cases appearances suggested that less careful operative procedures had resulted in partial or total destruction of the nasal septum, and in the making of a larger hole through the ethmoid bone into the base of the cranium.

All the specimens in the Macalister collection are dry skulls, i.e. without any covering of muscle, cartilage, or epidermis. The author, after prolonged examination, formed the opinion that access would be so limited by the lumen made by the external opening of one nostril, and again by the small size of the perforation into the base of

¹ See Appendix I for the relevant passage from *Arch. für Geschichte der Medizin*, 5 (1911).

² Herodotus II, 86 (translation of A. D. Godley in Loeb Classical Library).

³ By the kindness of the late Professor J. D. Boyd.

⁴ A vivid description of the vicissitudes of the collection is given by Sir E. A. Wallis Budge in *By Nile and Tigris*, I, 94 f. In a letter to Macalister, Budge expressed his disappointment that the skulls could not be purchased for less than 2 piastres each.

⁵ For Macalister's description of the collection see *J. Anthropol. Inst. of G.B.* 22 (1893), 111-21.

the skull, that no instrument could be designed to 'draw out' or 'hook out' the brain either before or after immersion of the body in the embalming salts.

In these days it is not possible to secure human material on which to test such theories. In an attempt to throw further light on the subject it was decided to use the heads of two sheep (*Ovis domestica*). The salesman expressed grave doubts as to the possibility of using them for experimental purposes. 'Even when a head is kept in a refrigerated room', he emphasized, 'the eyes and the brain begin to putrefy after a few days.' This observation provides both a clue to the reason why so many mummies have been found with the eyes removed and replaced by artificial ones, and an explanation of the custom of removing the contents of the cranium.

Replicas were made of the instruments illustrated in Sudhoff's paper. Similar instruments are exhibited in the Wellcome Museum, London, described as 'Replicas of Instruments used by the ancient Egyptian Embalmers'. Herodotus stated that these instruments were made of iron;¹ Sudhoff, however, submitted a privately owned specimen to be analysed, and this was found to consist of 99 per cent copper and 1 per cent iron. He considered, therefore, that it could be regarded as a copper instrument, the iron being present as an impurity. As copper and, later, bronze were the principal materials used by the Egyptians for tools during most of the Dynastic Period,² the author concluded that the design of the instrument was the prime factor, rather than the metal of which it was made. His replicas were made of the more easily available stainless steel.

Entrance into the base of the cranium through the nose was easily effected in spite of the narrowness of the passage. A surgical hammer and chisel were used, and although such instruments would not be included in the equipment of the embalmers, primitive alternatives would have been as effective. Owing to the distal position of the brain in relation to the nose, the pathway to it was long and narrow, but in spite of that, when an instrument was inserted into the brain and withdrawn, the end, whether open or coiled, held a covering of brain tissue which was glutinous and viscid in character. Although this covering was thin, it would have been only a question of time before most of the brain was removed by repeated insertions and withdrawals of the instruments. This demonstration completely disproved the author's original belief that such operative procedures were impossible because of lack of access to the brain. It is to be emphasized that the tissue was not 'drawn out with a hook': it was removed by degrees because its viscid consistency caused it to adhere to the instrument. The design of the instrument had little effect on the amount of tissue withdrawn at each application, and the circular-ended one was as effective as the coiled one; the criterion was rather the size of the end of the instrument. It also became quite clear that repeated insertions of the instrument caused lacerations of the tissue which reduced it to a semi-fluid condition. Had this process been continued and the head turned face downwards, much or all of the tissue would eventually have drained away.

¹ Loc. cit.

² On the sparse evidence for the use of iron in Egypt before the Late Period, except for small objects made of meteoric iron, see Lucas, *Ancient Egyptian Materials and Industries* (4th ed., 1962), 235 ff.

Upon conclusion of this experiment it was decided to test the effects produced on the various tissues by covering the head with, or embedding it in, natron, to ascertain if tissue reaction accorded with the results obtained by the ancient embalmers. Although many authorities have held that the body was immersed in a solution of natron, Lucas and others¹ are of the opinion that mummification was accomplished by covering the body with the dry salts, a view which the author shares. He decided, therefore, to use one of the combinations of salts found by Carter in the tomb of Tut'ankhamūn and analysed by Dr. H. C. Cox. The formula selected was that of the natron found in a vase placed in front of the canopic canopy, namely:²

| | |
|----------------------------------|----------------|
| Sodium carbonate and bicarbonate | 84.7 per cent |
| Common salt | 1.5 per cent |
| Sodium sulphate | 13.8 per cent. |

As the brain had not been entirely removed from the experimental head (hereafter referred to as 'head no. 1'), the partially emptied cranial cavity and the nose were filled with natron. Since head no. 2 was intact, a large orifice was now made through the parietal bone, thus exposing the brain, so that there would be a large area of natron in close proximity to the tissue. The object of the experiment was to determine the anti-bacterial action, if any, of the salt mixture. The two heads were placed on a layer of natron in an earthenware vessel and then covered by 2 cm. of natron. During the course of daily inspections the only changes observed were an insignificant amount of yellowing and crystallizing of the covering salts, and a slight odour of putrefaction, which persisted, but did not increase, with the passing of time. After 43 days the heads were uncovered and the most conspicuous feature observable was the moist condition of the eyes. This observation would appear to be in accord with the findings of the embalmers, because had the natron caused desiccation of these organs, there would have been no necessity to remove them and replace them by artificial ones. The parts of the epidermis and muscle not covered by thick hair had changed to a dark brown colour and had assumed a leathery consistency. The contents of the cranial cavities emitted an odour of putrefaction, but this was no greater than when the heads had been covered with natron. The large area of tissue exposed in head no. 2 showed the onset of degenerative change indicating that the natron retarded decomposition but did not prevent it. These findings were confirmed by head no. 1, where the brain was more fluid in character and less glutinous than it had been.

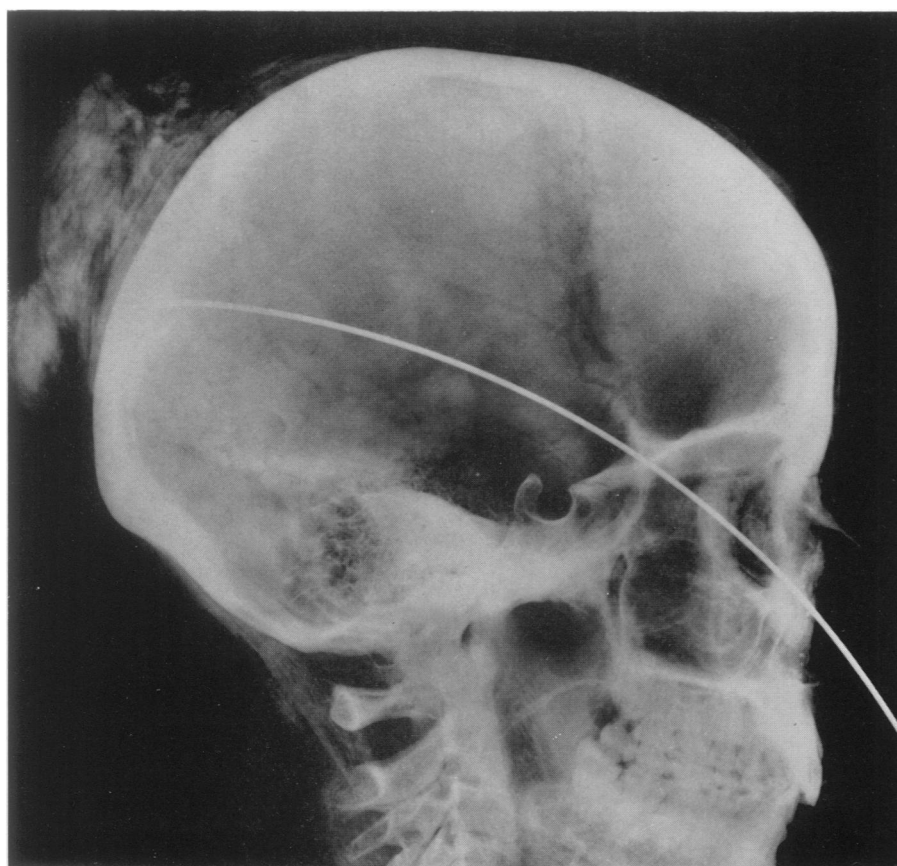
It can be assumed that the organs of *Homo sapiens* would react *post mortem* in the same way as those of *Ovis domestica*. It is evident, therefore, why the ancient embalmers removed the brain and the eyes before, or during, the process of mummification. How much it is to be regretted that *no* experiments can reveal the thought process that led them to adopt this particular surgical procedure of entering the cranium. No doubt the embalmers wished to avoid making signs of external violence, thus impairing the appearance of the head; but they happened nevertheless to choose the most effective method of extraction. It is also clear to see why bitumen has been found in many

¹ Op. cit. 281 ff.

² See Carter and Mace, *The Tomb of Tut'ankh-amen*, III, 178 f.



1. Head of a mummy in University College London. The entrance to the nose is undamaged. The face retains some gilding which originally covered it. The hair is in immaculate condition. Upper incisor teeth are visible where the upper lip has been cut away

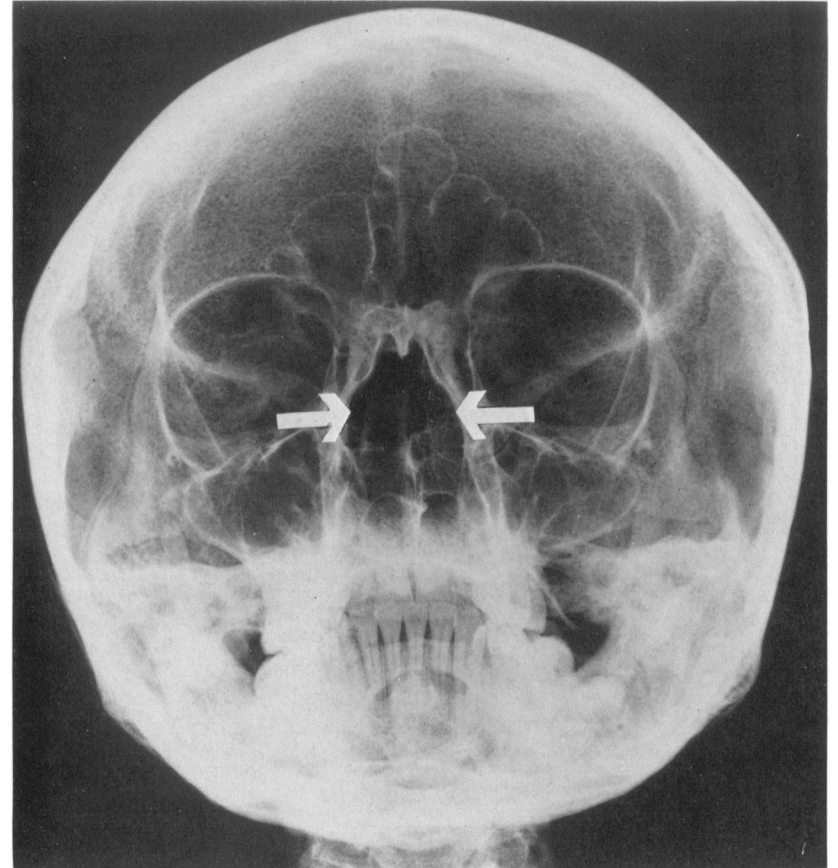


2. X-ray of the same head showing the explorer-instrument passing from the external part of the nose through the cribriform plate of the ethmoid bone to the distal part of the skull. The hair and soft tissue covering the skull are easily discernible

BRAIN REMOVAL DURING EMBALMING

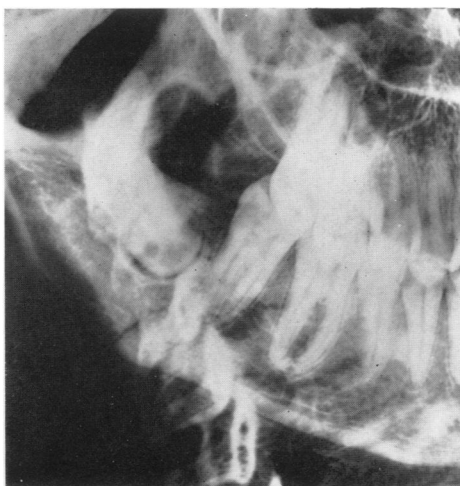


1. Head of a mummy in the City of Liverpool Museums. No evidence of damage to nose. Eyes have been ablated and the lids drawn over some insertion since disappeared. Lips are drawn tightly together. There is a complete absence of hair, lost before completion of mummification, for there are traces of gilding from nose to posterior part of skull. Complete absence of signs of external facial damage

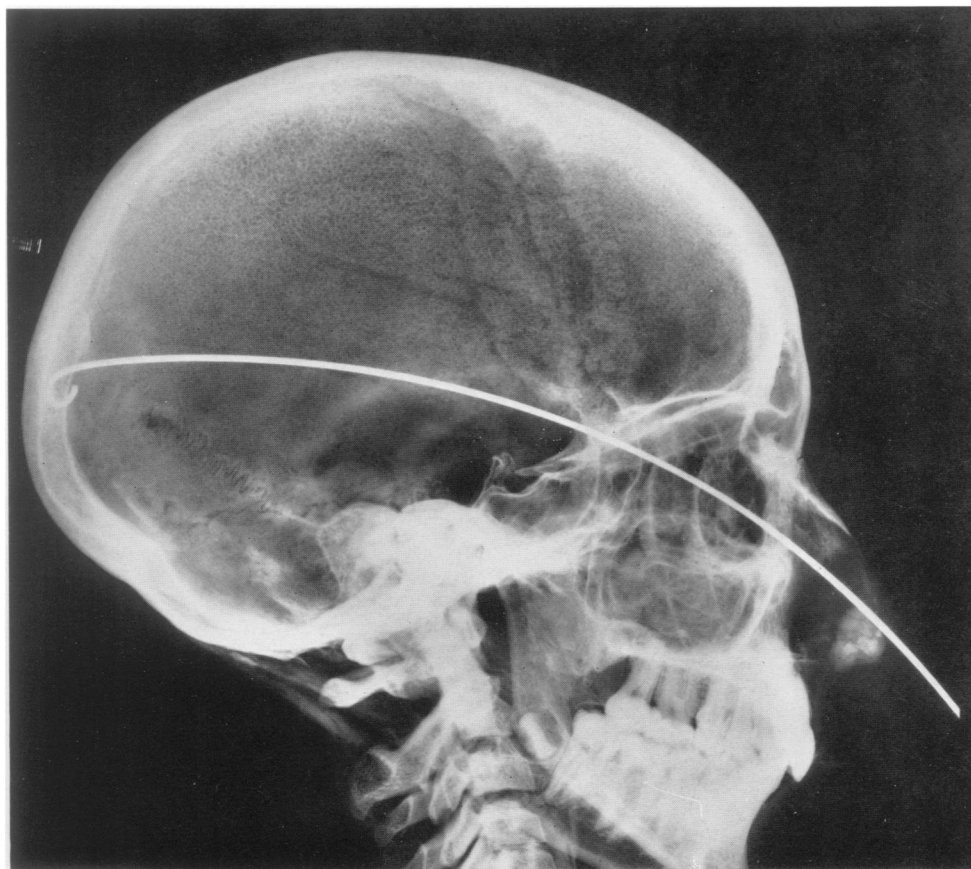


2. X-ray photograph of an occipito-mental projection of the same head, showing between the white arrows the entrance into the base of the cranium via the pierced cribriform plate of the ethmoid bone

BRAIN REMOVAL DURING EMBALMING



1. X-ray showing part of the Liverpool head. Although there are no external signs of damage, this photograph shows that the mandible is fractured at the angle of the ascending ramus between the second and third molars. This damage must have happened *ante mortem*; while it could not have been responsible for death, its cause may have been the responsible factor

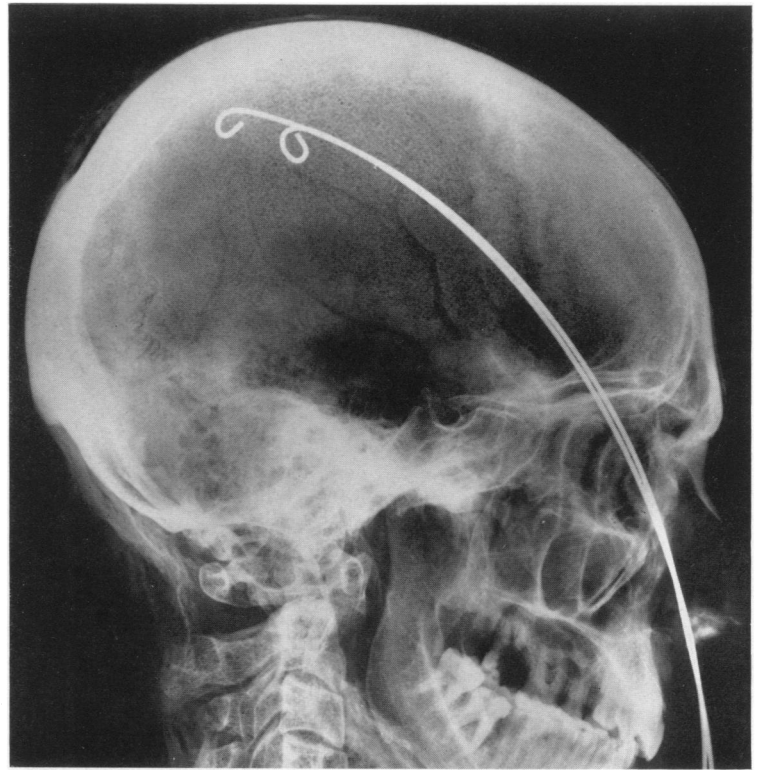


2. X-ray of the Liverpool head showing the explorer demonstrating the clear passage from the entrance of the nostril through the base of the skull to its posterior part. The first two molars are fully erupted, but the third molar is only partially developed, thus showing the age at death to have been approximately fourteen years

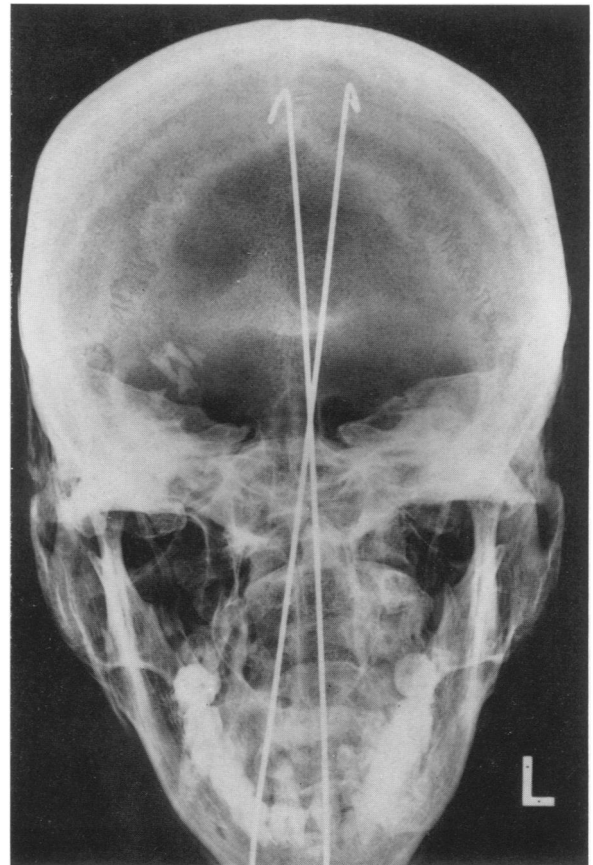
BRAIN REMOVAL DURING EMBALMING



1. Head of a mummy in the Macalister Collection in Cambridge, showing two stainless steel explorers passing through entrance to nose, through fractured cribriform plate of the ethmoid bone, and thus into the cranial cavity. Upper lip partially removed, exposing upper incisor teeth. Profile shows complete absence of nasal manipulation. There is a good covering of hair



2. This X-ray shows two explorers, one through each nostril. The upper molars show signs of caries and abscess formation



3. This X-ray shows roots of teeth lying in posterior base of skull. These are extraneous, having entered the skull *post mortem* via the canal in the spinal column

BRAIN REMOVAL DURING EMBALMING

mummified skulls, since it must have been melted and poured in via the nostril by conscientious embalmers to ensure the complete destruction of any residual tissue.

Conclusions

1. Experiments performed by Sudhoff and by the author confirm that extraction of the brain through the nostrils as stated by Herodotus is feasible, but that the often used illustrative expressions 'drew out' and 'hooked out' are inaccurate.
2. Experiments carried out by the author on *Ovis domestica* prove that the use in mummification of dry natron retards decomposition but does not preserve eyes or brain.¹

Appendix I

Karl Sudhoff, after describing in detail the design of the various instruments probably used for brain-extraction, explains his experiment in the following words (from 'Ägyptische Mumienmacher-Instrumente', in *Archiv für Geschichte der Medizin*, 5 (Heft 3, Aug. 1911), 165 f.):

Ich war nun in der glücklichen Lage, mit solchen Haken die Probe auf das Exempel machen zu können und an einer Reihe von Leichen im Sommer 1908 in der Leipziger Anatomie den Versuch zu unternehmen, das Gehirn aus der Schädelhöhle zu entfernen, was in vollkommenster Weise und mit Leichtigkeit gelang — ohne daß die Nase irgendeine äußerliche Veränderung zeigte.

Das Einstoßen der Lamina cribrosa auf einer Seite glückte sofort; ebenso gelang leicht das Zerbrechen der Lamina perpendicularis, ja die völlige Zerstörung der oberen und unteren Nasenmuschel. Eine derartig zerstörte vordere Schädelgrube zeigt nach der Präparierung des Knochens oberstehendes Bild, vollkommen übereinstimmend mit dem Befunde, wie wir ihn an Mumien treffen. Ging man nun in den Schädel ein, zerriß das Tentorium und alle sich entgegenstellenden festen Membranteile im Schädelinnern unter Einhaken der Hakenspitzen oder unter Stoßen mit der gewölbten Stumpfsseite des Hakens, rührte das leicht mazerierte Gehirn um und legte die Leiche dann auf den Bauch, so lief unter leichtem Nach-helfen mit dem Haken oder seinem Stielende in 15—20 Minuten das Gehirn so gut wie völlig aus, wie wir (der findige Anatomiediener HAGEDORN und ich) uns nachträglich bei der Eröffnung der Schädelhöhlen in einer ganzen Reihe von Fällen überzeugen konnten.

Appendix II

The following comment has been supplied by Mark Lister Patterson, M.B., M.R.C.P., pathologist at the National Heart Hospital:

Following the interest and endeavour of F. Filce Leek in the palaeopathology of brain extraction demonstrated in his foregoing experiments on *Ovis domestica*, it proved possible to examine the method described by Sudhoff in *Homo sapiens* using instruments modelled on those previously described. An entry was made through the cribriform plate of the ethmoid bone via the right nostril into the cavity of the skull. No great force was needed to break through the bone, and an artificial foramen

¹ To all those who assisted in the preparation of this essay by word or deed, the author wishes to offer his most profound thanks. In particular to Messrs. Ilford Ltd. who were responsible for all the photographs and X-rays used as illustrations; to Dr. David Dixon of University College London by whose permission photographs and X-rays were made of the mummy head in the Petrie Collection; and to Miss Dorothy Slow, Keeper of Archaeology of the City of Liverpool Museums, for the loan of, and permission to experiment with, the mummy head no. 15.207.2.

of approximately 1.5 cm. in diameter was created. The brain tissue was then macerated by slow rotation of the rod and the tentorium cerebelli and falx cerebri were torn away to produce a contiguous cavity between both sides and the posterior fossa.

The brain was then evacuated in three ways, all of which were probably available to the embalmers. The first followed Sudhoff, and confirmed that brain tissue would drain from the skull if the body were correctly positioned. This method had the disadvantage of being very slow. Secondly, the brain was easily and quickly aspirated through a wide-bore catheter and piston-type syringe. Thirdly, the brain was effectively evacuated by irrigation of the interior of the skull with water which flushed the macerated tissue rapidly through the artificial foramen.

Hence it seems both reasonable and possible that the embalmers did use the method described by Herodotus to overcome the difficulties of brain putrefaction, at least in a significant proportion of bodies.