

John Hunter, velvet and vascular surgery*

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Despite the devastation wrought by incendiary bombs in 1941, John Hunter's museum still contains many of his fine specimens. Most of these demonstrate his remarkable powers of observation and his experimental skill, as well as his genius in applying experimental study to the relief of human suffering. Nowhere, perhaps, is this more brilliantly shown than in his study of the growth of the antlers of the male fallow deer (*Cervus dama*). His observations on the effects of ligation of the external carotid artery of a deer led on to his trial of femoral artery ligation in the treatment of popliteal aneurysm.

The antler specimens in the museum were collected by John Hunter in Richmond Park by gracious permission of HM King George III, and they are described in Part 1 of the Descriptive Catalogue of the Physiological Series (1). Before discussing these specimens it will be helpful to relate a few details of the life history of this deer species.

Growth of antlers

In Western Europe the calves of the fallow deer are born around the month of May. At birth they are weak but they gain strength rapidly and are romping together by July. At the age of 6 months the sexes begin to differ widely: the females continue to grow with little change, but the young stags are readily recognised by their wider foreheads, which make the muzzle look narrower, and by a straggly growth of longer hairs under the neck. Only in winter do two humps appear on the forehead of the young male as the first sign of the impressive headgear which follows.

The humps on the male head are known as the pedicles; they are never shed, never lose their skin, and continue to grow year by year as fresh antlers are formed and later shed. The young stag has single unbranched antlers in the first year, adding further tines (or spikes) with each succeeding year. By February the stags begin to drop out of the herd to cast their horns; first the old ones and then the younger ones progressively, age by age, down to the youngest in June.

The females come on heat in August and the stags search them out, often travelling many miles in the wild. As soon as a stag joins a herd of does his first thought is to chase all the other males away. If he succeeds in this endeavour, the stag announces his triumph by bellowing. This also serves as a warning to any nearby pretenders, for the bellow can be heard up to a mile or two distant.

Fights between males at rutting time are not unusual and are often fierce, sometimes leading to death of one or even both contestants. The victor settles with his harem near water for he needs to drink constantly though he eats nothing. He spends his time serving the does and only leaves them when each has been covered several times. Then he roams off in search of further conquests or simply retires. Once the bellowing period is over he remains silent until the following year. The does, after a 9-month gestation, isolate

themselves in May and bear one or two calves which usually suckle until the autumn.

Hunter's specimens

The growth of the male antlers takes place between spring and early autumn. The mature antler consists of bare bone, but, in the rutting season when growth is still occurring, the antler is covered by a vascular membrane, similar to periosteum, continued from the pericranium and ensheathed by a velvety integument continuous with the skin of the head, and covered with fine hairs.

The Hunterian museum specimens are numbered from 163 to 187. The vascular membrane and hairy covering of velvet is well shown in No 163 and in No 164 (Fig. 1) which

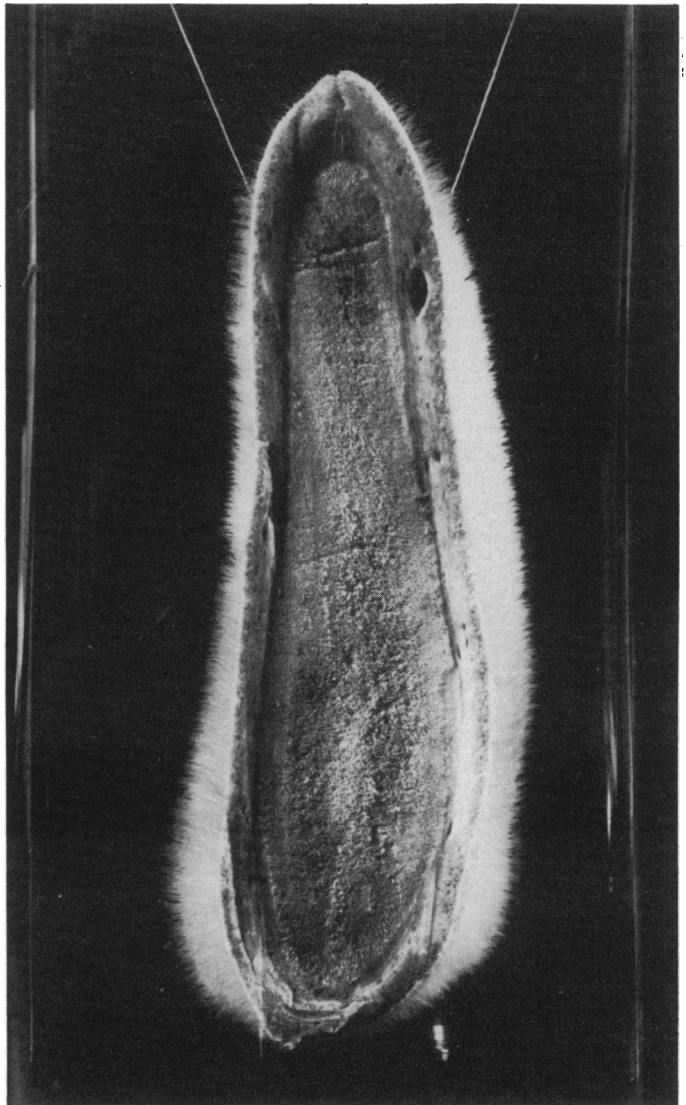


FIG. 1. Injected specimen from the palm of the antler in the growing state. The velvety covering is well shown (No 164).

* Based on a demonstration given to the Hunterian Trustees on 23rd June 1982.

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are injected specimens from the so-called palm of the antler in the growing state. Similar changes are seen in transverse and horizontal sections of the antler palm (Nos 166 and 167) which were also injected in the growing state to show the delicate honeycomb of central cancellous bone with tougher cortex. In No 165 Hunter removed the velvet and partly turned back the vascular periosteal membrane (Fig. 2).

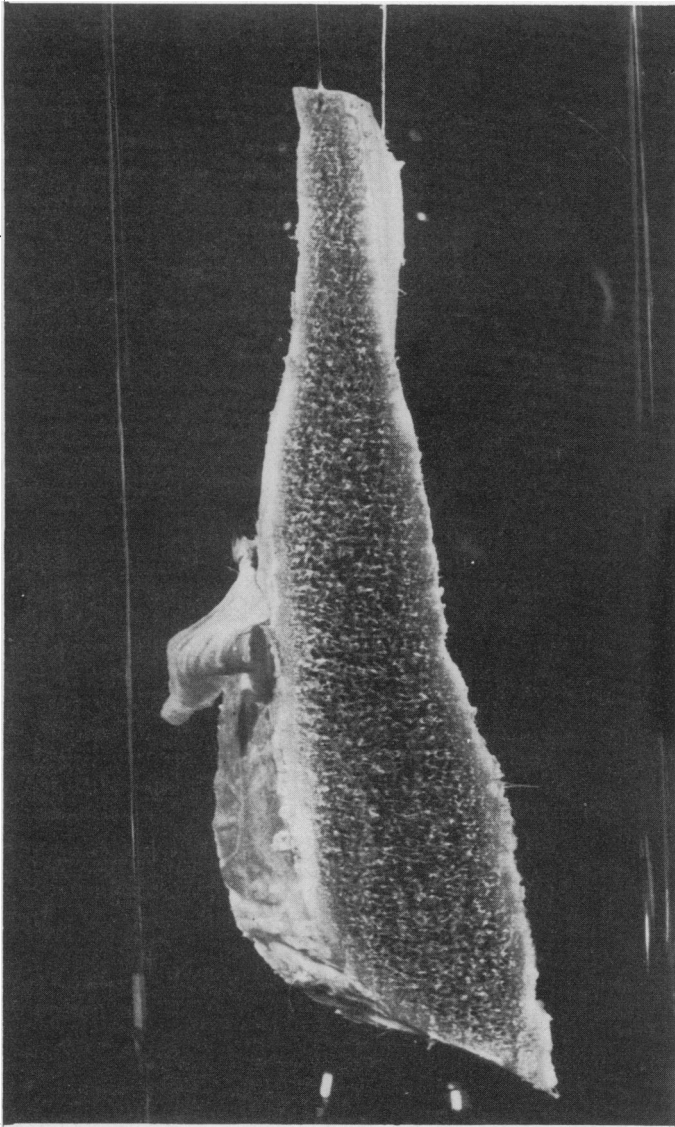


FIG. 2 Velvet removed and vascular periosteal membrane partly turned back on left of specimen (No 165).

Three further specimens show the peculiar structure of the horn substance. The first of these, No 168, which was injected and then deprived of earthy material by being steeped in acid, demonstrates the outer layer of bone and periosteal covering of part of the palm and the base of one of the branches, with the vessels plainly shown in the substance of the bone (Fig. 3). These vessels are derived from the superficial temporal branch of the external carotid artery. Specimens 172–178 were also minutely injected, steeped in acid and preserved in oil of turpentine, to show the vascularity and bone structure of the growing antler. A transverse section of the palm of an antler shows the fine internal vessels with no large branches externally (No 175, Fig. 4).

In specimens 179 and 180 the growth is almost complete and continuity of horn and skull, and of velvet and skin, is shown. At this stage the burr, or pearl, forms around the base

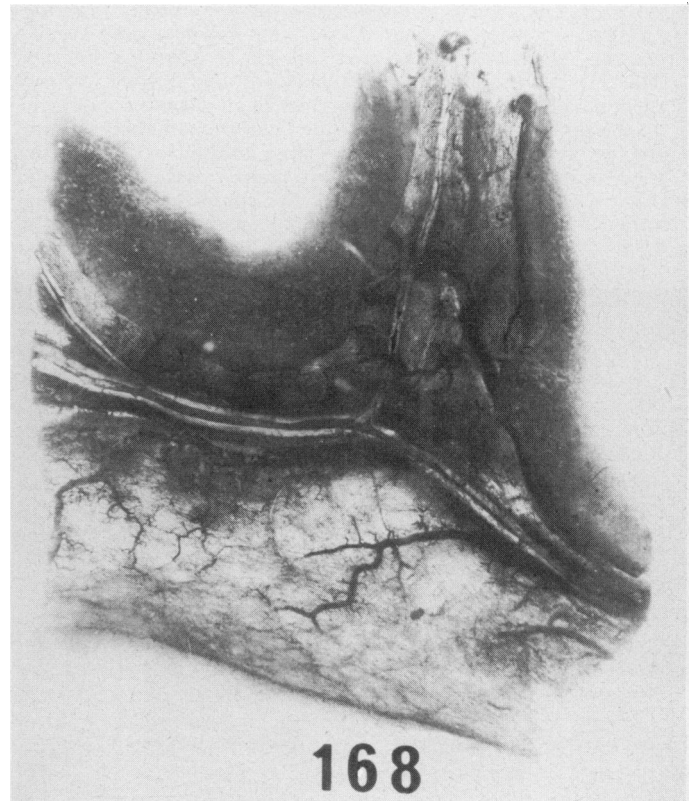


FIG. 3 Showing junction of the palm with base of a branch and vessels in substance of bone (No 168).

preparatory to separation of the antler, as seen in the fully grown example of part of the frontal bone and burnished antler deprived of all its coverings (Fig. 5). The burrs, or osseous tubercles, project outwards and induce absorption of the outer covering. But the burr also defends the margins of the cranial integuments around the base of the antler and does not diminish the size of the vessels by direct pressure.

Specimen 181 (Fig. 6) and Nos 182–185 show the connection between the antler and the osseous pedicles on the skull. The last of Hunter's specimens (Nos 186 and 187) show the start of interstitial absorption of the root of the antler, which makes it soft and yielding just before shedding, thus facilitating separation of the outer last-formed compact bone from the internal spongy part. The illustrations give a good idea of the changes, but visitors to the museum should take the opportunity to study the specimens which are not illustrated here.

It was at a dinner of the Hunterian Society in 1879 that Richard Owen (conservator of the museum from 1842 to 1846) made some interesting observations on these antler specimens (2). He went on to refer to John Hunter's experimental study on the effects of ligation of the external carotid artery in the male fallow deer:

'In the prosecution of Hunter's researches on this subject, he was granted the privilege of making experiments on the deer in Richmond Park, from which the preparations in his museum were supplied. In the month of July, when the buck's antlers were half-grown, he caused one to be caught and thrown; and, knowing the arterial source of supply to the hot "velvet" as the keepers call it, Hunter cut down upon and tied the external carotid, upon which, laying his hand upon the antler, he found that the pulsations of the arterial channels stopped and the surface soon grew cold. The buck was released and Hunter speculated upon the result; whether the antler, arrested at mid-growth, would be shed like the full-grown one, or be longer retained, as happens after castration. A week or so after the vivisection, he drove down again to the park and caused the buck to be caught and thrown. The wound was healed about the ligature; but, on laying his hand on the antler, he found, to his surprise that the warmth had returned, and the channels of

supply to the velvety formative covering were again pulsating. His first impression was that his operation had been defective. To test this, he had the buck killed and sent to Leicester Square*. The arterial system was injected. Hunter found that the external carotid had been duly tied. But certain small branches coming off on the proximal or heart side of the ligature, had enlarged; and tracing on these he found that they had anastomosed with other small branches from the distal continuation of the carotid, and these new channels had restored the supply to the growing antler.'

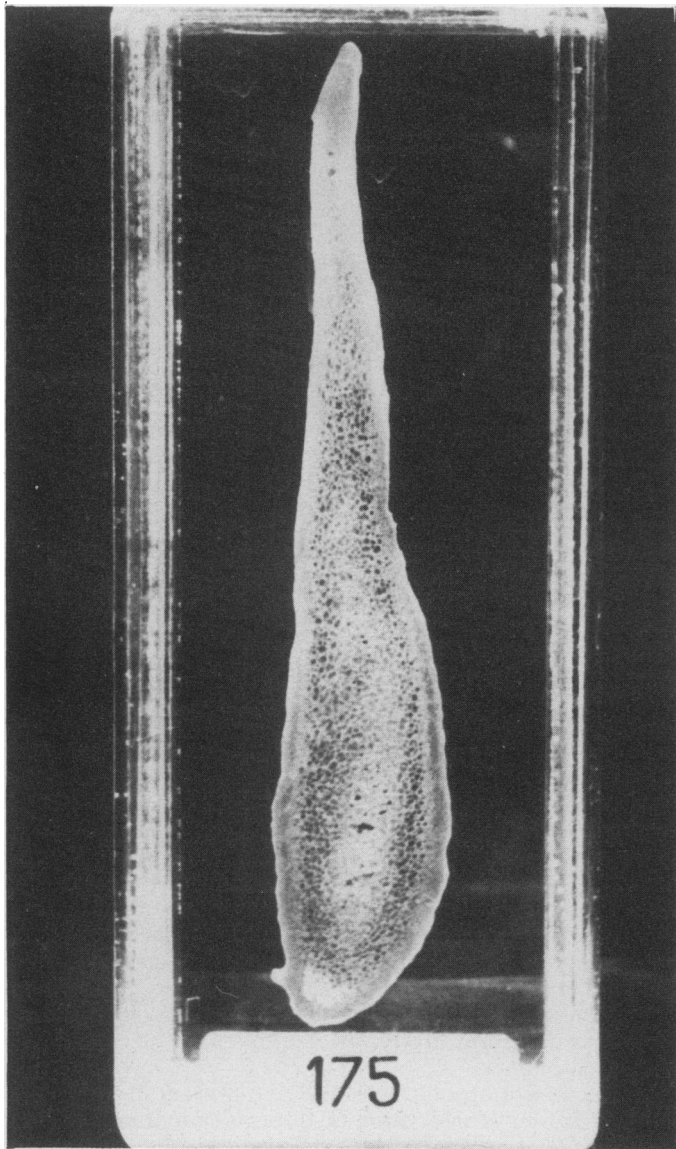


FIG. 4 Palm of antler with injected fine internal vessels (No 175).

The clinical application

In his lectures on the principles of surgery (3) Hunter shows a remarkably clear appreciation of the pathology of arterial aneurysm. Moreover, in contrast to many of his contemporaries, he recognised the need for operation in appropriate conditions. But he was plainly dissatisfied with the risks to life and limb attendant on the operations then practised. In the case of popliteal aneurysm this entailed direct exposure of the diseased vessel and ligation of the artery immediately adjacent to the aneurysm, an exceedingly difficult operation in those pre-anaesthetic and pre-antiseptic days.

Hunter's recognition of the significance of the collateral circulation in preserving the vitality of the deer's antler

* Hunter then lived in Leicester Square.

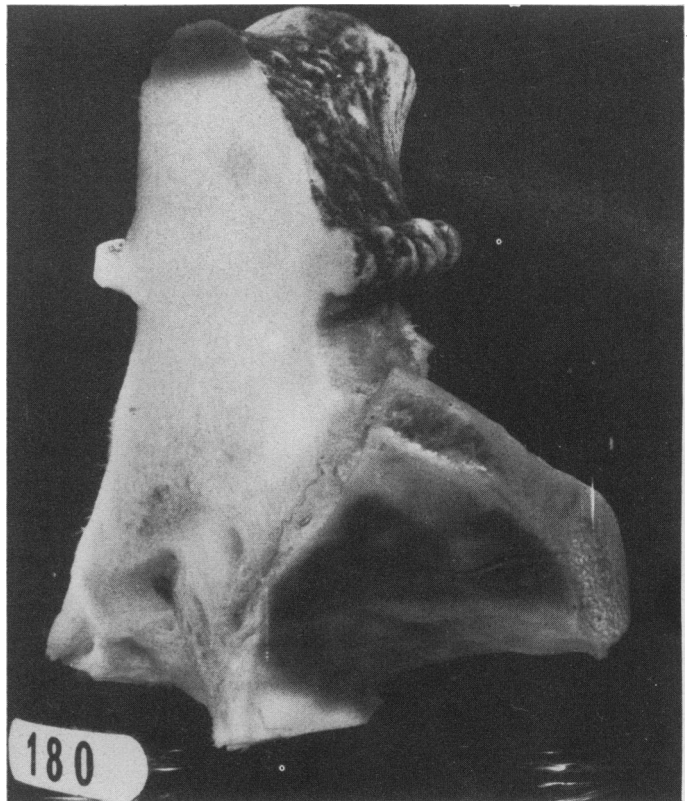


FIG. 5 Showing fully developed burr around base of antler (No 180).

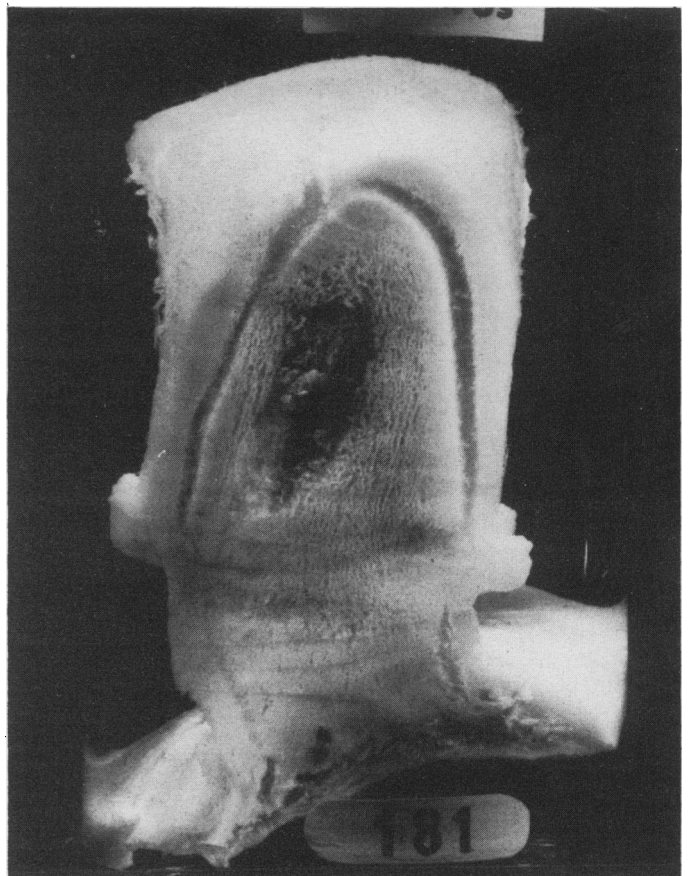


FIG. 6 Junction between antler and osseous pedicle showing line of separation (No 181).

provided the clue to a much simpler and safer operation for popliteal aneurysm. He soon put forward the concept of ligating the superficial femoral artery in the upper part of the adductor canal. It is of particular interest that Hunter's first such operation was successfully performed shortly after his recovery from a period of serious ill-health which had compelled him to spend some 6 weeks at Bath. It was from there that Anne Hunter, on 13th September, 1785, wrote to Edward Jenner in Berkeley to tell him that John 'has been tormented with a flying gout since last March, and we are come here in the hope of some more favourable crisis before the winter'. This is recorded by J. F. Palmer (4) and he goes on to state:

'The infirmity of his body had not, however, abated his ardour for the improvement of his profession, and it was in December of the present year that he planned, and carried into execution, his famous operation for the cure of aneurism; that of tying the artery at a distance from the tumour . . . and thus introduced into surgery an improvement which has been more fruitful in important results than any since Paré's invention of the ligature for divided arteries.'

A full description of the first operation is included in volume 3 of Palmer's 'Works' (5). Everard Home assisted at the operation and a copy of his account of it is also included in Part 1 of the Descriptive Catalogue of the Pathological Series of the Hunterian Museum (6) though a short summary will suffice here. The patient was a coachman, aged 45, with a 3-year history of popliteal swelling which, by that time, had caused gross displacement of the hamstring muscles. There was a firm brawny swelling of the leg and foot. At operation, an untightened tourniquet having been applied to the upper thigh, some 3 in. of the femoral artery was laid bare through an oblique incision. Four separate ligatures were applied to the artery with the intention of avoiding great pressure on any one part. The ends of the ligatures were left long and brought out through the wound, the edges of which were held together with sticking plaster and a supportive linen roll.

Although the patient's recovery was delayed by local inflammation and abscess formation before the ligatures sloughed out, he returned to his normal occupation as a hackney-coach driver. He made no complaint of the limb following his discharge from hospital but died of a remittent fever some 15 months after operation. Everard Home records that 'leave was procured, with some trouble, and considerable expense, to examine the limb seven days after death, at which time it was entirely free from putrefaction'. The dried specimen (P 275) in the museum shows the residual aneurysm reduced to the size of a hen's egg, and Home recorded: 'The conclusion to be drawn from the above account appears to be a very important one, viz., that simply taking off the force of the circulation from the aneurismal artery is sufficient to effect a cure of the disease, or at least to put a stop to its progress, and leave the parts in a situation from which the actions of the animal oeconomy are capable of restoring them to a natural state.'

Home's reference in the above description to 'some trouble, and considerable expense', makes one speculate as to whether there was some resort to the resurrectionists in order to retrieve the limb from the grave!

John Hunter's own conclusion from this experience was that in future cases he would only apply one ligature, and that he would not close the wound and attempt healing by first intention. His fourth case bears testimony to the wisdom and efficacy of this decision for that patient survived no less than 50 years after operation, and this specimen is also in the museum. Everard Home, in Palmer's 'Works' (7), states that 'Mr Hunter's fourth patient was a coachman, 36 years old'. The popliteal aneurysm was large and caused severe pain

with swelling of the leg and venous engorgement. The patient's condition was so bad that operation was at first thought inadvisable. However, Hunter wisely changed his mind and, at operation in 1787, a single ligature was applied to the superficial femoral artery immediately distal to the origin of the profunda. The ligature separated on the twenty-ninth day and the wound healed by second intention in the seventh week. There was subsequent abscess formation and fever, but the patient eventually left hospital in the fourteenth week to convalesce in the country. It was Hunter who sent him there and paid all his expenses until health was fully restored. So much for those who believe that total health care was unknown prior to establishment of the Welfare State!

The remarkable specimen from this last patient was procured by Thomas Wormald, presented to the Hunterian Museum in 1857, and demonstrated at his Hunterian oration in 1865 when he was President of the College. He had shown great enterprise at the time of the patient's death in 1837 when he persuaded the widow to allow him to remove

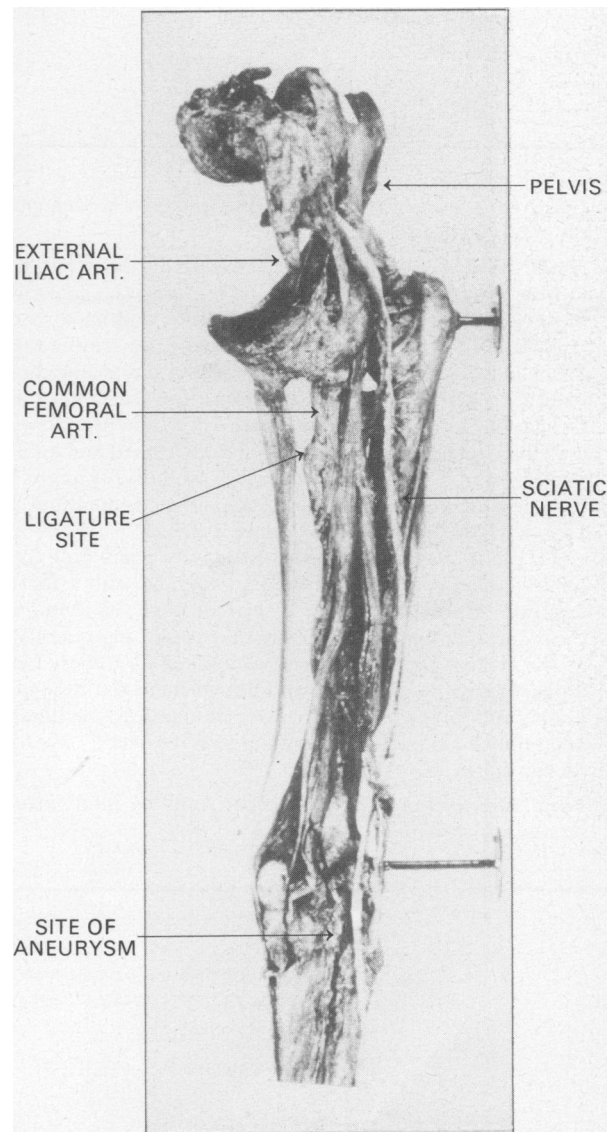


FIG. 7 Posterior view of injected and dried specimen from fourth patient 50 years after ligation of superficial femoral artery. The main artery is obliterated from the site of ligation down to the division of the popliteal artery. Anastomoses were chiefly established through the sciatic, posterior profunda branches and the descending branch of the external circumflex. Specimen P 279.

and preserve the affected hind limb. By then the patient was 86 years of age; he had survived for 50 years after his operation and had outlived his surgeon by 44 years. His specimen shows the aneurysm, in Wormald's own words, 'represented by a small calcareous tumour about the size of a filbert' (Fig. 7).

Thomas Wormald was born 9 years after Hunter's death and probably learnt of the patient from Everard Home. That dried, varnished and, to the casual visitor, deceptively unexciting-looking specimen, together with the beautiful specimens of antlers 'in velvet', bears silent and dramatic witness to the genius of the Founder of Scientific Surgery.

I am indebted to Mr George Elia, Department of Dental Science at the Royal College of Surgeons, for the photographs, and especially for his skilful reproduction of the antler specimens in John Hunter's original bottles.

References

- 1 Descriptive Catalogue of the Physiological Series in the Hunterian Museum of the Royal College of Surgeons of England. Edinburgh and London, E & S Livingstone, 1970: part 1, 4-8.
- 2 Descriptive Catalogue of the Physiological Series in the Hunterian Museum of the Royal College of Surgeons of England. Edinburgh and London, E & S Livingstone, 1970: part 1, 8.
- 3 Hunter J. Lectures on the principles of surgery. In Palmer JF, ed. The works of John Hunter. London: Longman, 1853; vol 1, 543-51.
- 4 Palmer JF. The works of John Hunter. London: Longman, 1853; vol 1, 96 and 97.
- 5 Palmer JF. Idem, vol 3, 601.
- 6 Descriptive Catalogue of the Pathological Series in the Hunterian Museum of the Royal College of Surgeons of England. Edinburgh and London, E & S Livingstone, 1966: part 1, 185.
- 7 Palmer JF. Idem, vol 3, 604 and 605.

In the 18th century anal fistula was treated by laying open but in the following case a ligature was used in addition to incision of the track with scissors.

A GENTLEMAN of about forty YEARS old came out of the Country, labouring of a *Fistula in Ano*, breaking out on the left Side; it arose from a *Phyma* (I suppose): The *Sinus* was large and painful, the Matter having spread under it. If I had laid this open by Incision the Lips would have lain hollow, and have rendered the Ulcer slow in curing; therefore I removed them by Caustic, laying the Ulcer open to the *Anus*; and after separating the Escar, digested, incarnated and cicatrized it: Then made a Search with a Probe, putting my Finger *in Ano* the while; and feeling the Probe pass into the Gut about an Inch high, I prepared a Ligature, and with a Probe-Needle passed it up into the Gut; then turned the End of the Needle downward under my Finger, and made a Deligation, as in the like Case hath been shewed, and applied a Stupe spread with *Unguentum Nutritum* over all. The next Day dressing it again, I found the Part a little healed; and a Pile that was before the making of the Ligature lank and withered, swell'd, and beginning to inflame; wherefore doubting it might be troublesome, I cut it off close by the Root, and rubbed it with the Caustic-Stone, to stop the Bleeding, and consume the Remainder of it. Then I dressed up the Escars with a Pledget spread with *Unguent, Basilicon*, and the *Nutritum* over all.

THE fifth Day I tightened the Ligature again and dressed it up with a Stupe spread with *Unguent Nutritum*, as before; and as occasion offer'd, I syringed the Part affected with a *Decoct. Hordei*, with a little Syrup, *de Ros. ficcis*. About the tenth Day of the Ligature, I observed it cut so near through, as it was easy for me to divide the Rest by a Snip of a Pair of Scissors; yet in Consideration that the Ulcer was deep, and consequently the Lips so cut would lie high, and be apt to receive Excrements, which might make it painful and very troublesome, I chose rather to free my self of them, by rubbing through them with a Caustic-Stone: Which having done, and flatted them as I designed, I pulled the Ligature to me, and the while passed by Probe-Scissors under, and divided the *Sinus*; and pulling away the Ligature uncut, dressed up the Ulcer with a Pledget dipt in *Basilicon* warm, and applied a Stupe wrung out of red Wine over it. After Separation of the Escar, I incarnated and cicatrized with *Unguent, Tuthiae*, &c. as aforesaid.

From 'A treatise on the Fistula of the Anus' by John Astruc. London. Printed for John Brotherton, at the Bible next Tom's Coffee-house in Cornhill 1738.