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John Hunter, the father of scientific surgery



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In era of bloodletting and imbalances of the four humors, John Hunter (1728–1793) challenged tradition and defined surgical scholarship. He introduced the modern approach to surgery: Begin with a thorough understanding of anatomy and physiology, meticulously observe the symptoms of disease in a living patient and post-mortem findings of those that died of it, then, on the basis of the comparison, propose an improvement in treatment, test it in animal experiments, and try the procedure on humans. He used the approach with success to treat popliteal artery aneurysm with ligation of the superficial femoral artery in 1785. The site of his operation, the adductor canal, is one of a handful of anatomic structures better known by its eponym.

He rejected the prevailing approach to surgically enlarge gunshot wounds to retrieve the projectile and remove foreign bodies based on his wartime observations of soldiers recovering from gunshot wounds. He made lasting contributions in dentistry and comparative anatomy. His thousands of specimens are preserved today in the Hunterian Museum at the Royal College of Surgeons in London, England.

Edward Jenner, discoverer of variolation, was his favorite and most famous student. Other pupils were the next generation of leaders in British surgery, including John Abernathy, Henry Cline, Astley Cooper, William Blizard, and Anthony Carlisle. His trainees from the U.S. became leaders of American surgery: John Morgan, Phillip Syng Physick, Wright Post, and William Shippen. They embodied Hunter's legacy as the creator of the modern surgical scientist.

Early years and professional career

John Hunter's life has attracted interest for more than 200 years (Figure 1). Wendy Moore, a medical journalist in London, wrote a well-received biography in 2005 titled *The Knife Man*.¹ James Palmer, a surgeon in the early 19th century, compiled Hunter's major publications in four volumes in 1835 and added a short biography that includes many of Hunter's letters to Edward Jenner, his favorite house pupil.² Stephen Paget, surgeon and son of Sir James Paget, one of the foremost surgeons of Victorian England, wrote a biography in 1897 that included letters to Hunter's family and contemporaries.³ Most of this article draws facts from their books.



Born in 1728 in East Kilbride, Scotland, Hunter was the youngest of 10 children. He had little formal education. Moving to London in 1748, he was initially hired as a dissection assistant by his older brother, physician William Hunter, a famed anatomist whose lasting contribution would be in obstetric anatomy. John proved to be a gifted anatomist himself and was soon running practical dissection classes and giving lectures.¹

William arranged for John's entry into the top level of London surgery. Soon after his arrival the younger Hunter studied with William Cheselden, a sexagenarian and long established as one of London's most celebrated surgeons, at Chelsea Hospital for the summers of 1749 and 1750 until the latter's infirmity forced his retirement. In 1751 John then apprenticed in surgery with 38-year-old Percival Pott, just named surgeon at St. Bartholomew's Hospital two years previously and on the brink of his own illustrious career. After he qualified in surgery, Hunter began work at St. George's Hospital in 1754, first as assistant, then house surgeon.² His natural dexterity and prior experience with his brother served him well in surgery, along with an insatiable curiosity and boundless energy.

He became a partner in his brother's school of anatomy, with his share of lectures and demonstrations. He fell short of his older brother's talent for demonstration and teaching, but his skill was in dissection, which he pursued with passion and a zeal for describing what he found. His first publication was in 1762 on the descent of the testes in an appendix to a publication written by his brother, *Medical Commentaries*, a screed in which William defended the Hunter brothers' priority on the anatomy of the descent of the testis and the role of the lymphatics on the return of tissue fluid to the circulation.⁴

Hunter's articles fell into three broad themes: anatomy and surgery, dentition, and comparative anatomy. He was especially interested in processes that sustained life and, when they ceased, caused death. He suspected that it had something to do with the generation of heat and electricity, so several of his papers dealt with thermogenesis among animals and vegetables and the electric organs of rays (torpedoes) and electric eels. On the other side of the ledger he studied decay of organs after death, beginning with what happened to the stomach after death. He speculated on the process that kept the stomach intact during life, and when it disappeared at death, allowed the organ to burst. Naturally he was interested in a man who recovered after seeming to drown, and whether he could revive a clergyman who was condemned to hang.¹

Exhaustion brought on by 10 years of intense study, plus a respiratory illness that risked consumption, forced him to seek a warmer climate. He attached himself to the Royal Navy during its siege of Belle Île in 1761, then with the army on the peninsula until armistice in 1763. The salubrious climate gave time for recovery and an opportunity to study gunshot wounds. Published after his death, *A Treatise on Blood, Inflammation, and Gun-Shot Wounds* was a signal contribution. Among its most significant conclusions were that gunshot wounds should not be enlarged (the term then used was "dilation") for debridement and removal of the projectile and that amputation should only be done as a last resort.²

The reunion with his brother upon his return to London in 1764 was not congenial, so a partnership was out of the question. John was sore that William had appropriated John's discovery of the connection of uterine and placental vessels, a grudge he would harbor long into old age. In 1765 he opened a surgical practice in his London home where he lived with his wife, poet Anne Home, and four of their children. Even though he had only two publications—the addendum on testicular descent and addenda to another article—he was named Fellow of the Royal Society in 1767 on the basis of his command of science.³

He never acquired the wealth of his contemporaries. Over his first decade in practice his income was only around £1,000 a year, then a modest sum among London's successful surgeons. He spent far more than he could afford on bodies for dissection and overpaid for curiosities. Like all surgeons and anatomists of the day he engaged grave robbers, ironically called "resurrectionists," to procure bodies for study and examination. John Hunter's home on Leicester Square had two entrances: a respectable one for patients and students, one more sinister for the deliveries of corpses. Paget noted the legend that Hunter and his house were the model the main character and home of Robert Louis Stevenson's *The Strange Case of Dr. Jekyll and Mr. Hyde*, a topic thoroughly covered by Lloyd Axelrod of Boston in 2012.^{3,5}

He paid £500 cash to procure the corpse of the Irish Giant, Charles Byrne, the London Circus attraction. Justifiably afraid that his body would wind up on a dissection table, the almost eight-foot-tall giant had arranged before his death for his body to be buried at sea. Somehow his coffin instead was filled with rocks and his skeleton was on display in the anatomic collections of John Hunter.³

Nothing with regard to human anatomy escaped his attention. He described the circulation of the placenta, the olfactory nerves, and the development of the fetus in the womb. Beyond descriptive anatomy he wrote in depth on more complex developmental and pathological processes: bone growth and remodeling, inflammation, the pathology of gunshot wounds, venereal disease, and malformations of the heart. His interests included the pathology of infectious conditions, such as tuberculosis, suppuration in abscesses, and osteomyelitis. He researched inflammation in gunshot wounds, wound healing, and cancer pathology.² In the latter area he made distinctions between early and late stages of cancer of the breast and rectum and the involvement of regional lymph nodes as cancer spread.¹ His personal collection of more than 10,000 pathologic preparations of human anatomy and pathology largely came from his operations and post-mortem examinations.³

Popliteal aneurysm

Hunter was the first to use an inductive, scientific approach to medicine and surgery. He began with a thorough understanding of anatomy and physiology. He made close observations of a disease in a living patient, then made certain he performed the post-mortem dissection. The link between the pathology in the dead to the symptoms in the living suggested critical improvements in treatment. He hypothesized an operation, tested it on animals, and then completed his experiment by performing the procedure on a patient.¹

The operation for which Hunter was most famous is ligation of the superficial femoral artery for popliteal aneurysm, then a fatal condition that caused death by gangrene or rupture. Prior to his innovation the standard operation was ligation of the popliteal artery above and below the tumor, then opening the aneurysmal sac and scooping out the accumulated clot. The technical difficulty was the difficult exposure caused by confinement of the large aneurysm between the thick hamstrings and insertions of the posterior calf muscles, and the risk of bleeding if ligatures tore through vessels already weak from the aneurysmal process. The procedure was so frightening and outcome so hopeless that some surgeons recommended primary above knee amputation, then as now a debilitating operation.²

Hunter created experiments to test his concepts of pathology, such as grafting a human tooth onto a cock's comb to prove the feasibility of tooth transplantation, a procedure he advocated to replace a tooth lost to decay and extraction (Figure 2). However, his experiment to test the development of collateral circulation, ligation of the external carotid artery of a stag, is apocryphal. The antler on that side first became cold and stopped growing. Over two weeks it became warm and once more began to grow, a confirmation of his hypothesis that collateral vessels would develop in response to an occluded artery. Careful review by Lloyd Stevenson, a medical historian at Hopkins and McGill University, revealed that Hunter never wrote a report on his experiment, nor was there such a specimen among the thousands of items in the Hunterian Museum.⁶



Sir Richard Owen, the famous 19th century naturalist and paleontologist, was the first to document the stag experiment before a meeting of the Hunterian society in 1879, 86 years after Hunter's death. He got the story as an assistant at the Hunterian museum under its conservator William Clift, who in turn heard the story from William Bell, Hunter's assistant who prepared specimens and experiments for the surgeon. Stevenson argues that from his knowledge of human pathologic anatomy, Hunter knew that arterial collateralization was a feature of occlusion of native vessels, and the leg likely would survive the therapeutic ligation of the superficial femoral artery.⁶

A relevant experiment was conducted by his brother-in-law and student, Everard Home, the younger brother of Hunter's wife. He stripped the muscular coats off a dog's femoral artery until the wall was so thin blood could be seen flowing through it. The injured vessel did not dilate but healed in a fibrous tube no larger than the native vessel.² This proved to Hunter that the pathology of aneurysmal disease lay in the vessel wall itself. Ligation of the vessel where it was already weak explained the hazard of the conventional surgical treatment for popliteal aneurysm.

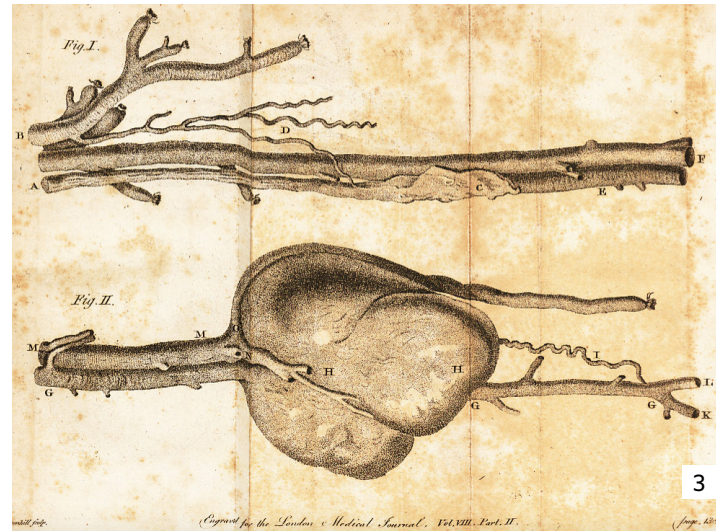
Hunter's insight was to ligate the artery above the knee in the anterior thigh where it was normal. The superficial femoral artery could be exposed medially through a limited incision as it passed through the adductor canal above the popliteal fossa where it became the popliteal artery.⁷ He knew from his vast knowledge of human arterial disease that collateral vessels enlarged in arterial occlusive disease. And if he had really ligated the external carotid arteries on one of the stags in Richmond Park, he had further experimental evidence that collateral circulation might compensate for the surgical occlusion of a major vessel.²

He had a chance to test his concept in a 45-year-old coachman who had a popliteal aneurysm for the past three years. It was so large it filled the back of his knee, pushed the tendons of his hamstrings apart, and embarrassed venous and lymphatic flow to the point where his leg was swollen and discolored. Through an incision along the inner margin of the sartorius muscle, Hunter exposed the superficial femoral artery. He passed a probe behind it and pulled a doubled length of thread around the vessel so that once the loop was cut he had two ligatures on the vessel. He took care to tie each ligature "so slightly as only to compress the sides together."² He then placed two more a little lower. The four ligatures, he hoped, would even the pressure on the vessel so that it was less likely to open when the ligatures were pulled away from the field.

Immediately after surgery the leg distal to the operative site was actually warmer than before, the aneurysm a third of its original size. The skin healed without complication, aside from a concerning discharge of blood in the second week after surgery that required reapplication of a tourniquet and a pressure dressing. The man walked out of the hospital six weeks after his operation and resumed his occupation. The incision healed firmly, aside from bits of ligatures working themselves out of the wound over the next few months, occasionally with some pus. Fifteen months after surgery he died during a febrile illness, no doubt brought on by driving a coach in the raw London winter.

Procuring his limb required "some trouble and considerable expense," but Hunter usually got the specimens he wanted (Figure 3).² Externally there was no evidence of swelling, but dissection found a firm egg-sized popliteal aneurysm filled with clot. A vessel entered the popliteal artery below the aneurysm, evidence of a collateral vessel, but he could not find a tributary above his ligature. Interestingly, the popliteal vein was obliterated, but three large venous tributaries were present, an indication of venous collateralization.⁸

It was the first surgical operation to be developed on the basis of a scientific study. Since the publication of the operation by Home, the space in the middle third of the thigh occupied by the superficial artery has since been called Hunter's canal, one of a handful of anatomic structures that is best known by its eponym.⁷



Dentistry

When Hunter returned to London after his war service, he found a niche in the closed and competitive London surgical community: dentistry. Preventive dental care was unknown, and the mania for sugar to sweeten tea led to an epidemic of caries.¹ "The state of dental surgery... was perhaps lower than that of any department of professional science or practice," wrote Palmer. "The treatment of teeth was still consigned to the hands of the ignorant mechanic, whose knowledge was limited to the forcible extraction of aching teeth."²

After his return to London, Hunter entered into a partnership with dentist James Spence, whose practice afforded the opportunity to study the anatomy and diseases of teeth. Hunter gave teeth their familiar names, such as "molar," "incisor," "cuspid," and "bicuspid." He recognized the role of gum disease in the loss of teeth. He recorded his observations and study in the first comprehensive study on the anatomy and diseases of teeth, a two-volume treatise that became the definitive text in the field and established his reputation among London's surgical elite. Its sales gave him a measure of financial stability.¹

Hunter's solution to the loss of teeth after extraction was to take the appropriate tooth from a human donor, generally someone who needed the money, and attempt to get the tooth to establish itself in the host's socket. The practice, a transaction between the poor to the rich, occasionally worked but only for a short time before the donor tooth was rejected. To test the concept Hunter successfully grafted a human tooth into a cock's comb, one of the most famous specimens in his collection (Figure 2). However, he made many attempts before he had the single success, an indication of its actual effectiveness.²

Comparative anatomy

Thought to be the inspiration for Hugh Lofting's *Doctor Dolittle*, Hunter accumulated an unparalleled collection of more than 3,000 animals, both live and preserved specimens.¹ From his days at sea at Belle Île and on the Iberian Peninsula he was interested in the fauna of foreign lands, with a particular interest in sea birds, lizards, and marine creatures. Captain James Cook gave him choice specimens from his explorations of New South Wales and the South Seas. One of the most celebrated was the skull of a kangaroo.¹

He maintained a property called Earl's Court, two miles outside London near Brompton, to accommodate his ever-growing collection of animals, including hedgehogs, pheasants, toads, silkworms, leopards, and an eagle. Queen Victoria gave him a bull. He also had the remains of the first giraffe exhibited in Europe. Buffalo and zebras grazed the fields around his home. Some animals were dangerous. His leopards once got loose and chased a neighborhood dog.³

Hunter used his collection for scientific study. From his unparalleled knowledge of animals, he used specific species to illustrate a particular aspect of anatomy or physiology. For example, Hunter thought the carotid arteries of the camel and the swan were particularly suited for the study of collateral circulation.²

Skeletons and preserved specimens were housed at his home. In 1785 he moved his specimens to greatly expanded quarters at Leicester Square, the place where he also accepted bodies through a backdoor entrance. The house thus was a truly fantastic place, full of curiosities in its public areas, and a more ominous secret area.⁵

Students

Hunter lacked brilliance as a teacher. He gave private lectures on anatomy and surgery, but the numbers of participants seldom exceeded 20. Still, his example inspired a generation of the country's brightest young surgeons, who followed him on rounds. An estimated 1,000 surgeons spent time in study under Hunter, where they saw his inductive approach to the study of surgery.¹

Some he accepted into his home as house pupils. Edward Jenner was among the first. He came to London in 1770 to complete his study of medicine when he was 21, and Hunter was 42. He followed the master everywhere: on the wards at St. George's, in the company of Hunter's wound dressers, to the West End to see wealthy patients, on the quay awaiting specimens from Captain Cook's travels. After he left his mentor's home in 1773 to begin his own practice as a country doctor in his native Gloucestershire, teacher and student, now close friends, maintained a frequent correspondence until Hunter's death.

Hunter's students included future prominent British surgical luminaries as John Abernathy, Henry Cline, Astley Cooper, William Blizard, and Anthony Carlisle. He also had American trainees, including John Morgan, Phillip Syng Physick, Wright Post, and William Shippen. Physick became Hunter's house pupil in 1789. When asked by Physick's father for a list of books that his son would study, Hunter went to the dissecting room where the cadavers lay. "These are the books your son will learn under my direction," the surgeon said. "The others are fit for very little."¹ After his return to Philadelphia in 1792, Physick became professor at the University of Pennsylvania and the Pennsylvania Hospital, where he introduced Hunter's approach to surgery to a new nation.

Hunter's house pupils and students embodied Hunter's lasting legacy as the creator of the surgical scientist. A quote from a letter to Jenner in 1775 summarized the master's lesson to his trainees. Jenner had asked his opinion on an experiment on hedgehogs that had posed problems. The nature of the study has been lost, but the master's response is a precis of the Hunterian approach. "Why think?" Hunter asked. "Why not try the experiment?"²

Death

Hunter suffered angina pectoris, and had his first attack at age 45 in 1773. It might have been complicated by syphilis, which he may have given himself when he inoculated his own penis in his studies on gonorrhoea. After another major setback in 1777, the year after he had been appointed surgeon extraordinary to George III, he had more frequent episodes, which seemed to accelerate his aging. Hunter, the experienced anatomist, knew exactly his disease. He made sure that upon his death two specimens be preserved: his Achilles tendon, which ruptured in 1767 and healed through secondary ossification, and his heart.¹

His fame did Hunter no good at St. George's. His rivals appeared to be determined to push him out of the facility. They set requirements for trainees, such as a full apprenticeship with a surgeon before acceptance for a training position. No longer could Hunter pluck William Clift, an orphaned, penniless lad from Cornwall, and shape him completely into a surgeon and eminent naturalist in his own right. They mandated that surgeons make regular visits to patients at the facility, with full knowledge that Hunter was physically unable to meet his obligation.³

In 1793, in a meeting for the admission of prospective students under the new regulations, Hunter advocated for two of his applicants. He knew that he would be unsuccessful, but he lost his temper. He was in a fury when he suddenly stopped speaking and collapsed dead. He was 65.¹

His request for postmortem examination was given to Home, his brother-in-law, who was now an established surgeon in practice with Hunter. He had assumed a greater part of Hunter's surgical practice and lecture schedule as the master's infirmity progressed. They had a close but troubled relationship from the day Home became his assistant in 1772, the year before Jenner's departure. As a relation he looked forward to taking the latter's place as favored pupil, but he was disappointed. Jenner was like a son to Hunter, and in comparison Home was dull and clumsy. He suffered through six years as an underling before leaving to join the Navy. Upon his return he still suffered in comparison to Hunter's younger, brighter acolytes. As a relation, he was often the closest target for the master's impatience and barbed comments.

As Hunter's colleagues gathered at the dissection table at St George's, Home laid the great man open. The coronary heart disease and the ossified Achilles tendon were confirmed. Then, inexplicably, he closed the incision without removing the specimens. As the body was taken away, the Hunterian collection was literally left without the heart of its founder.¹

The story of Home and the destruction of Hunter's priceless manuscripts, papers, and correspondence is a story equally compelling as the fictions of Drs. Doolittle and Jekyll and Mr. Hyde. Most of his fortune was spent in the acquisition and upkeep of his collections, estimated to be worth £70,000, so his death left his wife, son, and daughters nearly penniless. His household was dismissed, save Clift, who stayed as caretaker of the museum. In the midst of war, the English government under William Pitt refused to acquire the priceless collection. In 1799, six years after Hunter's death, the government bought all 13,687 pieces of the collection for the bargain price of £15,000. The museum was placed under the custody of the Company of Surgeons, renamed the following year the Royal College of Surgeons. Clift was named its first curator.³

Home was the sole family member who prospered after his death. Already giving his lectures, he stepped into Hunter's practice and position at Saint George's. In 1801 he demanded that Clift hand over "all of Hunter's papers—manuscripts, casebooks, lecture notes, catalogs, and letters," wrote Moore. "[They] were delivered to Home's house in a cart."¹

Over the next 20 years Home enjoyed enormous scientific productivity, reading an unprecedented 92 papers to the Royal Society, for which he won its Copley Medal and served its vice-president. In the highest circles of surgery, he served as sergeant surgeon to George III in 1808, was knighted in 1813, and was elected president of the Royal College of Surgeons in 1822.

Clift and the trustees of Hunter's museum, now under stable management, had spent years trying to wrest control over Hunter's papers back from Home. In 1823 Home and Clift shared a chaise to a meeting when Home mentioned that his house had suffered a fire that required the fire brigade to be called. When asked, he casually said that he had been burning Hunter's manuscripts. Clift broke down in tears.³ On the verge of being discovered of plagiarism, Home tried to burn the evidence. His jealousy of Hunter's favored house pupils was satisfied: He made certain to destroy Hunter's correspondence with Jenner and Physick.¹

Epilogue

Clift had the foresight to copy as much of Hunter's important unpublished work as possible, such as *A Treatise on Blood, Inflammation, and Gun-Shot Wounds*. Some Home had left untouched. Some of his work could be deduced from his writing and correspondence to others, such as Jenner. Still, the loss was immense. Unknown were the contributions Hunter may have made to Jenner's discovery of variolation (1796) and his contributions to evolution, anticipating Charles Darwin's *On the Origin of Species* (1859).

Hunter suffered one final posthumous drama. His widow could not afford the burial at Westminster Abbey that he deserved. Instead his remains were interred in a modest service attended only by immediate family and a handful of friends at St. Martin's-in-the-Fields where the rules prohibited a memorial plaque. In 1859, when coffins at the church were moved for re-interment, the decision was made to move Hunter's coffin to a place of honor in the north aisle of the Abbey. Francis Buckland, a surgeon and naturalist like Hunter, took the task of locating Hunter's remains among the 3,060 in St. Martin's church. After 16 days of searching he found it. There were only three left to examine.³

Home's senseless destruction did not diminish Hunter's legacy. The items in the Hunterian Museum might be viewed as curiosities of an age long past. The sheer volume and variety of the collection reflects the intellectual power of a man who set the example of today's surgeon scientist.

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Legends

- 1 Robert Thom. John Hunter: Founder of Scientific Surgery, from "History of Medicine," 1952. From the collection of Michigan Medicine, University of Michigan, Gift of Pfizer, UMHS.
- 2 Human tooth transplanted on a cockerel's comb. Blood vessels injected with dye demonstrate establishment of blood flow with the native vessels. Courtesy of the Hunterian Museum, Royal College of Surgeons of England.
- 3 Figure from Home's 1787 account of Hunter's operation for popliteal aneurysm. Top: Branches of the femoral artery into its main superficial (A) and profunda (B) branches. (C) superficial femoral artery at the site of ligation. (D) collateral from the profunda to the superficial femoral artery. (E) the superficial femoral artery above the popliteal fossa, (F) the femoral vein. Bottom: The popliteal artery (G) with the aneurysm sac (H). (I) collateral vessel from either the profunda or the superficial femoral artery. (K, L) posterior tibial and peroneal (fibular) arteries. (M) popliteal vein with two tributaries (N,O).