VICTOR HORSLEY WAS intrigued by newly discovered, ancient trepanned skulls, especially those that revealed that the operation was performed on living patients. He examined the man-made openings as an expert on the locus of the primate motor cortex and as a surgeon who had successfully removed parts of the motor cortex to treat Jacksonian epilepsy. He postulated that trepanation originated as a way to treat pain and epilepsy caused by depressed cranial fractures over the motor cortex. Like Broca before him, Horsley helped create the exciting *Zeitgeist* that led others in the late-1800s to explore, ponder, and write about ancient trepanned skulls. (Neurosurgery 48:911–918, 2001)

**Key words:** Broca, Convulsive disorders, Epilepsy, Horsley, Jacksonian seizures, Motor cortex, Trepanation

Trepanation (from the Greek *trypanon*, meaning auger or borer) has stirred the interest of brain surgeons since the 1860s and 1870s, when it was first realized that ancient human hands scraped or cut holes in the crania of living persons in Peru and France. Paul Broca (7–9, 15, 30, 60, 66, 68), who had been President of the Paris Surgical Society (1865), introduced cranial cerebral topography (1868), and became Professor of Clinical Surgery (1868), first involved himself with trepanned skulls in 1867, when he was shown a pre-Columbian Peruvian skull with cross-hatched cuts (7, 8). He then studied 4000- to 5000-year-old skulls from people who lived in France during the late Neolithic Period or New Stone Age (a period associated with polished stone tools, community life, farming, and the domestication of cattle) (29). Broca published scores of articles on the French skulls (10–13, 14, 16–25). He hypothesized that trepanation was first performed for the treatment of simple or benign infantile seizures (58, 69), which, he contended, primitive people would have associated with demons lodged in the head.

A second brain surgeon who was drawn to ancient trepanned skulls was Victor Horsley. For Broca, the study of ancient skulls was a long-lasting interest, but Horsley’s involvement amounted to little more than a brief or passing fancy. Nonetheless, his opinion regarding cranial fractures, epilepsy, and the origins of the practice of trepanation also contributed to the exciting *Zeitgeist* surrounding the discovery of these skulls in the second half of the 19th century. Indeed, the theories of both Broca and Horsley remain widely cited in the anthropological, archeological, and behavioral science literature.

The factors that drew Horsley to study the ancient practice of trepanation and his thoughts regarding the origins of this surgery are worthy of consideration, because of his impact on the field and the light this material sheds on an aspect of Horsley’s career that has received little recognition from neurosurgeons, brain scientists, or medical historians since his death in 1916. Surprisingly, Stephen Paget (57), Horsley’s first biographer, devoted only a few paragraphs to the subject, and Jack B. Lyons (49, 50), the author of a later scholarly book and a biographical article on Horsley, chose not to mention his trepanation contribution.

**VICTOR HORSLEY**

Victor Horsley (Fig. 1), who helped modernize brain surgery, was born in the Kensington area of London in 1857 (6, 40, 49, 57). Bright, energetic, daring, and optimistic as a child, Horsley retained these qualities into adulthood, although he also garnered a reputation as brash and uncompromising, especially regarding alcohol consumption and other social welfare issues.

When he was quite young, Horsley decided to become a surgeon. In 1874, he matriculated at the University of London, and he entered the medical school of University College in 1875. There he was

**FIGURE 1.** Victor Horsley (1857–1916).
drawn to Burdon Sanderson and Edward Schäfer, two world-class physiologists who promoted careful experiments on animals as the best way to advance modern medicine. Horsley won many awards as a student, and in 1881 he received his Bachelor of Medicine and Bachelor of Surgery degrees with a gold medal. After he graduated, Horsley obtained coveted appointments at University College Hospital and the Brown Institution, which had been endowed for veterinary medicine research. In 1886, he added the title of Surgeon to the National Hospital for the Paralyzed and Epileptic, Queen Square, to his credentials (Fig. 2).

Horsley agreed with the principles of asepsis, which had been made public by Lord Lister in 1867, and he became skilled at performing difficult new operations, including endocrine gland ablations, on animals. An important development was his use of aseptic surgical procedures to study cortical localization of function in monkeys, both at University College Hospital and at the Brown Institution. He was especially drawn to the “so-called motor cortex” (Fig. 3), a term Horsley used because he thought this area also performed somatosensory functions. During the mid-1880s, he published a series of important articles on the “so-called motor cortex” (2, 3, 36, 41, 42).

Horsley achieved considerably greater and more lasting fame in the area of human brain and spinal cord surgery, in which he applied the knowledge gained from his studies in monkeys to ill and injured human patients. He once wrote, “Experiments on the brains of animals closely allied to man has proved most fertile in the production of facts upon which very active treatment has been safely based” (36, p 344).

Horsley’s most notable surgical achievements include the treatment of epilepsy by cortical ablation, removal of an extramedullary spinal cord tumor, nerve sections for painful facial tics, operations for craniostenosis, attempts to surgically alleviate involuntary movement disorders, intracranial operations for subcortical tumors, and the development (with R.H. Clarke) of a stereotactic frame for subcortical surgery.

Along with William MacEwen (51–53) and Rickman Godlee (4, 5), Horsley endowed brain surgery with its modern look, one based on laboratory experiments, cortical localization, and aseptic procedures. Because of Horsley’s enthusiasm for brain and spinal cord surgery, his ability to devote most of his time to it, and the scope of his work, he, rather than MacEwen or Godlee, is often called “the father of neurological surgery” (34, 50). (The term “neurosurgery” was itself coined by Harvey Cushing, but not until 1905.)

In 1902, Horsley was knighted in recognition of his surgical achievements. But his impulsiveness, combativeness, and inability to see the world from different angles earned him lifelong enemies in the medical establishment and rendered him somewhat unpredictable to his friends. Horsley died in sweltering Amara (Mesopotamia) during the summer of 1916, possibly of heat stroke. He had been serving his country as an operating surgeon and army colonel dedicated to improving hospital conditions for wounded British soldiers in the Middle East.

SURGERY FOR EPILEPSY

It was Horsley’s bold attempt to cure epilepsy by ablating diseased parts of the cerebral cortex that led him to theorize about trepanned skulls. Since this work was based on his research on monkeys, the point can also be made that his cortical mapping studies also figured prominently in drawing him to comment on the mutilated Neolithic skulls that were then being unearthed in France.

Trepanation as a treatment for convulsions, especially seizures caused by head injuries, was practiced by ancient Greek and Roman surgeons (70). During the European Renaissance, craniotomies continued to be performed for epilepsy, especially of traumatic origin. The purpose of the operation, however, was simply to remove broken bone or to relieve a buildup of fluid or “evil” air; there was no attempt to remove diseased brain tissue.

FIGURE 2. The staff of National Hospital, Queen Square, in the 1880s. Victor Horsley is on the left, standing in the second row. John Hughlings Jackson is seated in the first row, third from left (photograph courtesy of Jack Lyons).
In the 1600s, for example, Duretus cured a boy of epilepsy by removing broken bone that pressed on the brain (70).

In 1828, a Kentucky physician named Benjamin Dudley performed successful trepanations for epilepsy of traumatic origin (27, 45). In his 1828 report, Dudley described five of his patients, each of whom had sustained an earlier injury to the head that guided him to a buildup of blood or fluid. Like others who dared to operate on the brain during this era, he was unwilling to venture forth if no cranial sign could guide him. With regard to a 6-year-old child who developed epilepsy after being kicked by a horse, Dudley wrote, “I have not operated on this case, because I am unable, from external appearances, to point out the source of the mischief” (27, p 21).

For many reasons, most of Dudley’s better-known 19th-century contemporaries in the major hospitals of Europe avoided trepanation, especially for “internal” disorders. First, existing anesthetics were crude and dangerous. Second, early 19th-century physicians were not yet guided by cortical localization, so they had no idea where to search for “hidden” problems if there were no external signs on the skull. Third, when these operations were performed in city hospitals, deadly infections routinely ensued. Finally, before the early 1870s and the insights of John Hughlings Jackson (43, 44), epilepsy was not regarded as a cortical disorder, much less one that could be treated by removal of diseased tissue on the surface of the brain.

On May 25, 1886, Horsley began to operate on his first three patients with epilepsy (35). John Hughlings Jackson, David Ferrier, Thomas Buzzard, and Charles Beevor were among colleagues at the National Hospital who assisted Horsley with his initial surgical patients. In contrast to previous operations for epilepsy, Horsley hoped to remove diseased brain tissue. He based his approach on Jackson’s theory that epilepsy can originate at the cortical level and on the knowledge he had gained of motor cortex localization in primates. Other factors that contributed to the new outlook were better anesthetics (he tried nitrous oxide and ether on himself) and carbolic acid sprays, soaks, and rinses to minimize the probability of infection.

Horsley’s first patient was a 22-year-old man from Scotland, who was under the care of Jackson and Ferrier. He had sustained a depressed cranial fracture 15 years earlier and developed Jacksonian seizures that started in his right leg. Because his life was threatened by status epilepticus, surgery was recommended. Horsley found a vascularized scar in the superior frontal sulcus, and removal of the scar and some surrounding cortex led to resolution of the seizure disorder.

Although Horsley’s third patient with epilepsy also had sustained cranial trauma, his second case was more notable. This patient had a tuberculoma under the dura that was localized solely on the basis of signs and symptoms. He was another of Jackson’s patients, and he exhibited “fits” that began in his left thumb and forefinger. Jackson suspected a tumor and advised surgery. Mainly as a result of his research with Schäfer (41, 42) and Beevor (2, 3) on thumb and finger movements elicited by cortical stimulation in monkeys, Horsley knew precisely where to apply his trephine. This patient also was cured of epilepsy.

Horsley presented his three landmark cases at a meeting of the British Medical Association in 1886, after which he was personally congratulated by many of the attendees, including Jean Martin Charcot and John Hughlings Jackson. A London physician named Gibbon stood up and commented, “The fact that the cases on which he had operated upon had been . . . rescued from what might be justly termed ‘a living death,’ and cured without a single hitch in a brilliant operation, was a sure guarantee that this splendid and successful surgery would be perpetuated” (35, p 675).

The idea of discovering a successful new procedure for curing epilepsy, perpetuating it, and then perhaps using it for related problems, was precisely what Horsley himself would now write about—not just an eye on the future of “modern” brain surgery based on localization and Listerian principles, but as he pondered the newly discovered trepanned skulls from France.

**HORSLEY ON NEOLITHIC TREPANATION**

Horsley never picked up a shovel to dig for prehistoric skulls, but he loved history, excavation, and exploration, and his hobbies included archeology and photography. At the time he studied the primate motor cortex and began to operate on patients with Jacksonian epilepsy, he examined and photographed the French Neolithic crania housed in the Broca Museum of Anthropology in Paris. After Broca died in 1880, these specimens were placed in the care of Drs. Duval and Topinard, who helped Horsley and permitted him to photograph the skulls. Horsley also obtained photographs of some specimens from other parts of Europe.

The Broca collection then contained approximately 60 trepanned specimens from France, including 10 fairly complete crania. (Many of these skulls now can be found in the Musée de l’Homme in Paris, but some were given to members of the

![Figure 4. A trepanned Neolithic skull found in France and examined by Broca, who thought this skull was trepanned both before and after death. Horsley presented his theory of trepanation in the mid-1880s, after he studied the motor cortex and then observed the trepanned skulls and fragments comprising the Broca collection in Paris (from, Broca P: Sur la trépanation du crâne et les amulettes craniennes à l’époque Néolithique: Congrès Préhistoriques (session à Budapest). Rev Anthropol 5:101–196, 1876 [18]).](image-url)
Société d'Anthropologie and have been lost.) In comparison, “the skulls operated on in all of Europe besides [France] could be counted on the fingers” (37, p 582). Figure 4 shows one of the trepanned skulls that had been especially intriguing to Broca, because only the smooth, middle opening seemed to have been made before death.

In 1887, from Horsley’s fertile mind emerged a theory extending that which Broca’s colleague Prunières (61, 62) had said in the previous decade regarding trepanation and head wounds. Horsley’s variation of Prunières’ surgical theory stemmed from the idea that the cranial holes made during the Neolithic period were not placed randomly. Not only were the forehead and face avoided (as Broca had astutely noted), but the holes seemed concentrated on the vertex of the head, above his so-called motor area. After Horsley used a single skull to draw outlines of the locations of all the trepanned holes, all doubts in his mind were erased:

By means of this composite arrangement it was demonstrated beyond question, that in almost all the known instances of this practice the opening in the skull was made over that portion of the surface of the brain which is known to be more especially the seat of representation of movement. This region of the brain, moreover, is the seat of origin of that special form of convulsions which is known as Jacksonian epilepsy, and which so frequently follows injuries to the skull and brain (39, p 101).

Horsley knew more about this part of the brain than almost anyone. It had been and remained the subject of some of his most important stimulation and ablation experiments in monkeys (2, 3, 36, 41, 42). In addition, he had just demonstrated to the medical world that the region was likely to be damaged or compromised in cases of Jacksonian epilepsy, and that a skillful and knowledgeable surgeon could treat motor seizures effectively by ablating diseased parts (35).

On the basis of first-hand experience, Horsley knew that a depressed fracture above this region might cause considerable surface pain and probably epilepsy. These insights formed the basis of Horsley’s further theories, and because he was comfortable with the pathological evidence demonstrating that the majority of the trepanned patients survived the operation, he suggested that first the tender scar might have been removed to control the local pain. The excision, he maintained, probably would have produced some relief. But in cases of relapse, additional operations would have been necessary. The primitive surgeons might then have removed splinters or pieces of broken bone as well as bone surrounding the injury site.

By excising the bone fragments pressing on the brain, these surgeons would have stumbled empirically on the remarkable discovery that such operations somehow eliminated or severely diminished the epilepsy that tortured these patients. “It was obvious that traumatic epilepsy would be relieved, if not wholly cured, by a trephining operation originally designed for nothing else but the relief of the fracture, a result which would certainly lead to wider adoption of the operation” (37, p 582). Put somewhat differently, “the operation would gain a certain reputation for the cure of convulsions generally, and as such might have been frequently practiced among savages to whom pain is of slight consequence” (39, p 102).

What became of the pieces of cranial bone that were removed during the surgery, or in some cases removed from the rims of the openings after death? In the previous decade, Broca had suggested that these bone fragments probably were used as amulets to ward off evil spirits and to bring good luck; in some cases the fragments were rounded off and holes were created. Horsley was in complete agreement with Broca (18) on the “rondelles.” They probably were thought to possess beneficial or supernatural powers, he maintained, and could have been carried or worn by Neolithic tribesmen to bring good luck (39).

According to Stephen Paget (57), Horsley, who was already a Fellow of the Royal Society, presented his motor cortex theory orally to the Royal Institution, the Anthropological Institute of Great Britain and Ireland, and the Harveian Society of London. On the basis of its absence from the list of formal lectures sponsored by the Harveian Society, Horsley’s presentation to that organization might have been less than an official sponsored lecture.

All three lectures were illustrated by numerous “lime-light” transparencies of the skulls and artifacts. The transparencies were projected on a screen with an “oxyhydrogen lantern.” The lantern was a common instrument at the time. It used a flame to heat lime, which in turn gave off intense white light for the presentation of illustrations. (It also was used to illuminate actors on a theater stage, i.e., to put them “in the limelight.”)

A half-page summary of the Royal Institution lecture of March 4, 1887 was published in the British Medical Journal 6 days later (37). In contrast, the Journal of the Anthropological Institute of Great Britain and Ireland of 1888 devoted six pages to a more informative abstract of Horsley’s lecture and the subsequent discussion (39). As for his Harveian presentation, the British Medical Journal of January 21, 1888, did little more than report that this event took place on January 5, 1888 (38). The wording was as follows:

Trephining in Pre-historic Times.—Mr. Victor Horsley, F.R.S., delivered an address upon this subject. He commenced with three propositions concerning the operation in the neolithic age, which he proceeded to maintain by the help of lime-light reflections upon a screen; he also exhibited specimens of the flint instruments of the period (38, p 137).

Although Horsley never published a full-length article on the topic, his lectures had considerable impact. To quote from Paget’s (57) biography of Horsley:

Never were lecturer and subject more happily suited to each other... the fact that trephining was practiced far and wide in the Stone Age found its proper exponent in him, who was both surgeon and antiquarian. The skulls in Paris had been waiting for him ever since they were trephined; and he set everybody talking about them (57, p 124).
THE RESPONSE TO THE THEORY

Professional anthropologists met Horsley’s surgical theory with considerable skepticism; many thought he had little understanding of the primitive mind. After Horsley’s presentation to the Anthropological Institute, Dr. James Paget, the highly respected father of Stephen Paget, opened the discussion by commenting on how the openings were made. Several others (including Buller, Priestley, and Ryle) then voiced their critical opinions.

One notable critic was Miss Buckland (39), who was well read on the subject and had met with Broca in 1879 to learn more regarding trepanation (26). She pointed out that Broca, a most careful observer, was unable to find signs of depressed fractures or trauma on the same skulls; this fact had led him to dismiss injury with or without traumatic epilepsy as the reason for the operation. She then defended Broca’s theory that the openings were made to facilitate the exit of evil spirits that caused convulsions and other problems:

That these openings were made to facilitate the exit of evil spirits who had caused the epilepsy or infantile convulsions, seems probable from the fact that in all ages such seizures were regarded as the work of evil spirits, whilst the use of cranial amulets as charms against diseases was not confined to neolithic times, but exists even at the present day... (39, pp 104–105).

Professor E. Tyrrell Leith spoke next. Citing examples from primitive tribes, he thought that it had not been sufficiently proved that Neolithic trepanation took place on live patients. He also stated that Horsley should not have sidestepped the subjects of “primitive psychology” and spirit possession:

No cases afforded the savage mind more striking proof of demoniacal influence or the efficacy of magical cure than epilepsy. It seemed, therefore, highly probable that the process of trephining had been employed by primitive man in order to expel the demon who possessed the patient, especially in cases of epilepsy (39, p 105).

The biggest problem, said Sir Francis Galton, who was then president of the Anthropological Institute of Great Britain and Ireland, was that although Horsley’s theory was bolstered by new and exciting findings from the brain sciences, it “implied more intelligence than savages usually shewed.” Hence “they were apt to proceed in a very off hand, ruthless, and unintelligent manner, following their fancies and superstition rather than experience” (39, p 106). Furthermore, he added, he knew of no evidence from travelers to Africa, New Zealand, or elsewhere to demonstrate that these “savages” even considered using trepanation to treat epilepsy of traumatic origin.

Horsley took these criticisms in stride, demonstrating none of the explosiveness or combativeness for which he was famous. He graciously thanked the society “for the kindly man-
Many other researchers also have commented on the depressed fractures common to ancient Peruvian skulls. Unlike the French Stone Age skulls, the male-to-female ratio is approximately 4:1, approximately half of the skulls reveal frontal area damage, and they exhibit significantly more holes on left side (64, 67). Such statistics suggest that trepanation was readily practiced as one way to treat traumatic injuries from right-handed adversaries, such as those caused by stones and clubs, in the war zones of Peru (34, 46, 59).

EPILOGUE

Horsley was a “new” brain scientist and an English surgeon who lived during the Victorian Era. He had cured epilepsy at the operating table and he was a bold, optimistic individual who enjoyed presenting new ideas, even if they were bound to be controversial. Given his background, his early achievements such as mapping the motor cortex and performing surgery for epilepsy, his personality, and the Zeitgeist, it is not difficult to understand what drew him to the French trepanned skulls. Nonetheless, Horsley was not a witness to what might have been a special or demanding tribal event. As a result, he, like Broca, could do little more than speculate from his personal knowledge base as to the motives behind the surgery.

Scientists still compare and contrast Horsley’s empirical-surgical theory of trepanation with the more anthropological-medical approach chosen by Broca, who attempted to connect seizure disorders in young people to supernatural events. Both orientations are intriguing and both are associated with great names, which may account in part for their longevity.

As originally conceived, however, neither the Broca nor the Horsley theory has withstood the test of time. For Broca, the major stumbling block proved to be the lack of solid evidence to prove that young people were routinely chosen for the operation (26). Without the age factor, his theory is more plausible. For Horsley, as discussed above, the idea that the openings were above the motor cortex proved problematic (65). Without this feature, his notion of traumatic injury also seems more reasonable.

Some of the best indirect support for both theories comes from tribes that have practiced trepanation well into the 20th century (1, 48, 54, 56, 63). The operation was performed among South Pacific islanders to treat fractures, epilepsy, insanity, and headache, and it was performed for headache with or without cranial fractures in Kenya and Tanganyika. Severe headaches and fractures after head injuries also were treated by trepanation in Uganda, Nigeria, Chad, Somalia, Libya, and among the Zulu of South Africa.

Notably missing from the 20th-century anthropological literature is solid evidence that trepanation was performed solely in a nonmedical context, such as for religious, magical, or cultural reasons. On the basis of these anthropological data, it would seem that both Horsley and Broca were correct in concluding that trepanation could have been performed in the distant past for neurological reasons.

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Broca before him, he helped expand knowledge in the final years of the 19th century.

More important to our understanding of medicine and magic in prehistory is Horsley’s ability, from the standpoint of a neurosurgeon, to reveal much of the meaning behind trepanation, including its origins, the reasons for its use, and the techniques of the early surgeons. Even today, disagreement persists among medical historians and osteologists regarding the true nature of cranial trepanation and whether it was performed occasionally for ritual purposes. Finger and Clower remind us that Horsley effectively initiated the debate that continues a century later.

There has been a resurgence of interest in the history of cranial trepanation. In April 1999, more than 70 scholars (including Dr. Finger) from all parts of the globe met at the University of Birmingham in England to discuss aspects of cranial trepanation in human history. This article is topical and timely, and it is a thoroughly interesting and informative read.

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The name Victor Horsley is well known to neurosurgeons throughout the world. His contributions to our field were enormous, and he can be referred to justifiably as the “father of neurological surgery.” Horsley’s interest in cerebral localization is also well known, as are his superb contributions to our understanding of the anatomy and physiology of the cerebral cortex. These authors have provided enlightenment on the obscure subject of prehistoric trepanation. As this article makes clear, the purpose of prehistoric trepanation is unknown. The authors’ research demonstrates that Horsley made an admirable attempt to develop his own theory, which had its own flaws. This article is particularly useful because it places these investigations in a contemporary perspective and reviews the studies already prepared by Paul Broca. The end result is the expansion of what would seem a passing historical footnote into a respectable review of a subject of continuing interest to historically minded neurosurgeons: the drilling of holes into the cranium.

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Victor Horsley of London was a multifaceted, brilliant, and productive Victorian era clinical investigator and surgeon. Dr. Finger, who is a noted neurohistorian and scholar, and Dr. Clower enlighten us regarding Horsley’s passing interest in prehistoric trepanation after a visit to the Broca museum in Paris. In 1887 and early 1888, Horsley gave several lectures in Great Britain on “Brain Surgery in the Stone Age.” Only brief abstracts and discussions were published as meeting proceedings. Horsley was of the opinion that in almost all cases, the openings were made over the motor regions of the brain, and he theorized that the openings were used to treat focal epilepsy and depressed fractures. The ancient surgeons may have been guided by local pain and tenderness with motor findings; it was found that both were relieved by removal of the cicatrix and underlying bony compression. Anthropologists in attendance disagreed with Horsley’s theory, and later analysis of the skulls raised doubt that the majority of the openings were over the motor cortical regions. Finger and Clower suggest that Horsley, who at that time was guided largely by focal seizures and motor findings in his early groundbreaking neurosurgical procedures, may have been biased in his explanation of prehistoric trepanation. In addition, at that time Horsley thought the motor cortex in humans extended more posteriorly into the parietal region. The authors discuss this as well as a number of other interesting physiological points from a historical perspective.

As a historical vignette, the article presents a refreshing slant on Horsley’s life and career in relation to trepanned skulls, and it is informative and well referenced regarding the general phenomena of prehistoric trepanation. The articles by MacNalty (1, 2) provide an additional source for information on Horsley’s life and career; although often overlooked, they mention Horsley’s lecture on trepanned skulls.

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