Editorial

Cushing and peripheral nerves

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How fortunate we are to read this splendid article on Harvey Cushing (1869–1939), touching on his early days as America’s father of neurosurgery and his work with peripheral nerves.19 In the late 1800s and early 1900s before World War I (WWI), as pointed out by the authors, intracranial and even spinal surgery was perilous and fraught with poor results. As a result, it was natural for Cushing with his interest in the nervous system to gravitate toward nerve cases. Bliss2 noted that during “[Cushing’s] first years back at Hopkins [after his European tour] he published as much about trigeminal and related [other] nerves as he did on intracranial lesions.” Long10 wrote that in Cushing’s 1st year as a faculty member at The Johns Hopkins Hospital, only 38 neurosurgical procedures were performed, and they were mainly performed for infection, trauma, and tic dolorous. By the time he left Hopkins for Harvard in 1912, 100 neurosurgical cases per year were being performed. By comparison, Walter Dandy, after the elapse of 40 years and in the year before he died at age 60 years in 1946, performed 500 cases. Of course, in Cushing’s early years he was busy in the laboratory as well as reading and writing and becoming the epitome of the surgical scholar. As a result, only a few of the relatively small number of cases he performed were nerve cases.

After his training with William Halsted, Cushing visited other outstanding surgeons and basic scientists in Europe, which gave him, along with his Hopkins training, the templates for his subsequent work with peripheral nerves. Much of the influence in the area of nerve may have been of British origin. Bowlby’s3 had already published a text on nerve and nerve repair in 1889. Bowlby wrote that in Cushing’s 1st year at Hopkins3 he published such as about trigeminal and related [other] nerves as he did on intracranial lesions.” Long wrote that in Cushing’s 1st year as a faculty member at The Johns Hopkins Hospital, only 38 neurosurgical procedures were performed, and they were mainly performed for infection, trauma, and tic dolorous. By the time he left Hopkins for Harvard in 1912, 100 neurosurgical cases per year were being performed. By comparison, Walter Dandy, after the elapse of 40 years and in the year before he died at age 60 years in 1946, performed 500 cases. Of course, in Cushing’s early years he was busy in the laboratory as well as reading and writing and becoming the epitome of the surgical scholar. As a result, only a few of the relatively small number of cases he performed were nerve cases.

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Publications

While in training at Hopkins, in 1900 Cushing wrote 2 papers in which he addressed the use of local anesthesia and its application for the repair of hernias and their related anatomy.4,5 Then, in 1902, he described cocainization of large nerves prior to their division to avoid blood pressure changes and shock. As mentioned by Tubbs et al.,19 this reflected his association with Halsted. In 1903, he was probably the first American to use and publish the crossover suture of the accessory nerve to the facial nerve (accessory or hypoglossal to facial, not facial to accessory or hypoglossal as it is sometimes mistakenly reported in the literature). The Polish surgeon Tomasz Drobnik had first published a paper about this operation in 1879 and Ballance had also written about it in 1895.15,21 In the late 1800s, radical mastoidectomy was increasingly performed for mastoiditis, and iatrogenic injury to the facial nerve was not uncommon. Of interest, these nerve transfers antedated by many years direct repair of the facial nerve in the temporal fossa, which was finally done by Sterling Bunnel in 1925. Today, nerve transfers for plexus stretch injuries and some other nerve palsies play a prominent role in the management of nerve lesions.

Cushing’s communications on nerves were, with the possible exception of the 1903 paper on a thoracic outlet case due to a cervical rib and fibrous band, not as groundbreaking as his subsequent papers on intracranial and pituitary tumors and other CNS lesions. He undoubtedly influenced Howard Naffziger who worked with him as well as Alton Ochsner who both wrote about thoracic outlet syndrome in the 1930s.12 However, as we can see from the 3 cases presented by Tubbs et al.,19 the work that Cushing did regarding nerves was done well and was more than most surgeons did at the time.

Case Reports

Some comments may be in order concerning the 3 cases published by the authors. These cases were, of course, not managed by today’s standards but that is the nature of both history and progress when we recognize it as such.

In Case 1, the complex midhumeral fractures and forearm radius fracture with arm level radial neurora were due to an arm caught in a revolving shaft. The patient underwent surgery performed by Cushing 17 years later in 1905, which was too late for effective regeneration, but not for resection of a painful neurora. Radial palsy was complete based on clinical examination and electrical stimulation findings. Of interest, when the patient’s fingers were flexed, slight dorsiflexion of the wrist was noted. (Subsequent experience with this nerve has shown this to be due to extensor tendon shortening as a result of radial denervation so that when fingers are flexed some dorsiflexion of the wrist occurs.13) Palpation of the chestnut-sized neurora “elicited[ed] contractions of the trapezius” (I believe Cushing meant the triceps). At the time of operation, Cushing did use an apparatus to stimulate exposed nerve and muscle. The neurora was resected, and the proximal nerve was split in two, with “the lower portion...in contact with a few branches to the trapezius” (but again, I believe Cushing meant triceps muscle) and was left alone.

The distal radial stump could not be located at the...
arm level, so the nerve was found at the forearm level between the biceps and brachioradialis and traced proximally to a very atrophic distal stump. (What an operative pearl! This step antedates the writings of many authors who subsequently wrote about this maneuver.) Half of the proximal stump was stretched down to the atrophic distal stump and sutured in place. (Grafts were seldom used at that time and as can be found in the texts of the author’s references were either allografts or autografts from amputated limbs.)

In Case 2, a flail arm was due to a very severe contusive/stretch injury. The physical examination was very thorough and extremely well done and even included an early description of Horner syndrome. The surgery was performed 10 months postinjury, much better timing than that in Case 1. No muscles responded to galvanic stimulation. At operation in 1905, a severely scarred plexus was dissected without division of the clavicle. The fifth and sixth cervical nerves had some anatomical continuity with the upper trunk, and these structures were dissected away from the scar. Other elements were avulsed and the distal stump of the seventh cervical nerve was brought to the bottom side of the sixth cervical nerve where it began to form the upper trunk and was sewn to it. (If you will, this was a very early end-to-side repair, or in terms of the direction of potential regeneration, side-to-end suture.) Follow-up was conducted 205 days postoperatively, and supraclavicular galvanic stimulation caused “erection of fine hairs over his left chest, back, and shoulder as low down as to the line of sensory anesthesia,” but I gather there was no evidence of sensory or motor recovery at that time.

Cushing was indeed courageous to operate on the brachial plexus given that such surgery was performed by only a limited number of individuals at that time.13 Harris and Low9 had reported on cross-union of nerve roots (spinal nerves) for Erb’s palsy in 1903. Although a spate of papers on obstetrical palsy began to come out in the early 1900s, it was not until 1912 that Tuttle20 reported nerve transfer using upper cervical spinal nerves to more distal upper brachial plexus elements and then, Taylor18 commented on adult plexus surgery in 1920.

In Case 3, this extraordinary patient underwent surgery in 1926 while Cushing was at Harvard. The woman was 30 years old and had an injection injury and subsequent soft-tissue infection near the elbow. The result was an ulnar palsy with claw deformity of the little and less so the ring fingers. The infected site was subsequently incised and drained, and then later on the area was injected with mercurochrome. Some 19 months after the injury and infection Cushing performed only a neurolysis of the ulnar nerve. Of course, stimulation and recording studies were not available then for this lesion in continuity.

Involved in the case was Hugh Cairns, an Australian with education at Oxford after WWI. After his training with Cushing, he returned to the London hospital and then later became the first Nuffield Professor of Surgery at Oxford.14 He taught the Cushing methods to many Europeans who returned home and became leaders in neurosurgery. Cairns noted a blue hue to the muscles as he and Cushing dissected out the nerve. Postoperatively, Cairns obtained further history from the patient that when the infection was originally drained, the muscles had a green hue. (Perhaps a gram-negative infection had occurred after the injection injury.) Cushing was concerned that he would have sectioned “the flexor carpi ulnaris” branch had he not exposed ulnar nerve beneath that muscle. (We now know that the flexor carpi ulnaris branches are multiple and sectioning of one would have little or no consequence. Indeed transection of the entire ulnar nerve at the elbow level usually does not result in flexor carpi ulnaris paralysis due to more proximal input to that muscle.) He was worried about sectioning of the “flexor sublimis group.” (These branches are median in origin and located on the radial side of the forearm. Perhaps Cushing meant the flexor profundii branches to those muscles for the fifth and fourth fingers since they are of ulnar origin and located in the area of the dissection.)

At 15 days postoperatively, the patient reported parasthesias in the ulnar nerve–innervated fingers, but there was no objective evidence of sensory improvement. There is no note of galvanic stimulation or other stimulation used postoperatively. It is of interest that such modalities were available and sometimes used by Cushing and a few others at that early time. Currently, stimulation of not only muscle but sometimes nerve is used to attempt to hasten recovery.4

By 1926, Cushing had experience in WWI and undoubtedly had seen many nerve injuries. He was director of Army Base Hospital 5 and then Chief of Mobile Hospital 6 in 1916–1917 and served as the senior consultant to the Army in Neurosurgery. During WWII, there was a hospital, the Cushing Hospital, which was named for him. Of even greater interest, William Van Wagenen, a former Cushing trainee was chief there and he and Frederick Lewey published during that period The Cushing General Hospital Regime for Treatment of Peripheral Nerve Injuries (http://www.societyns.org/society/bio.aspx?MemberID=7557).

World War I Surgeons and Nerve Injuries

Samuel Harvey worked with Cushing at Army Base Hospital 5 while Harry Kerr served as the executive for Cushing while he was in charge of military neurosurgery.14 Frank Teachenor saw duty in France and at Camp Dodge where he taught training courses in nerve repair to incoming military physicians. Byron Stookey served in the British Royal Army Medical Corps under the well-known orthopedist Sir Robert Jones and then later with the US Army Medical Corps. He returned to Columbia, New York, where he became a prominent nerve surgeon. Howard Naffziger, who studied with Cushing in Boston and subsequently wrote about nerve repair and thoracic outlet syndrome, held many posts in the US Army Medical Corps during not only during WWI but also in WWII. Loyal Davis served in WWI although not in the medical corps, but then played a significant role regarding nerve injuries in WWII.25 W. J. Mixter, R. E. Semmes, E. B. Towne, G. J. Heuer, C. Frazier, C. Dowman, C. Coleman, and Dean Lewis commanded other wartime hospital units. Working for them were many surgeons, some of whom later became neurosurgeons and most of whom had exposure to a good many nerve injuries. In the Euro-