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In this issue, Menovsky and van Overbeeke provide a comprehensive review of intracranial nerve repair and Sawamura and Abe present a variation of hypoglossal-facial nerve anastomosis with preservation of hypoglossal function. Procedures designed to repair and reconstruct cranial nerves are aided considerably by modern microsurgical techniques, but they actually originated more than a century ago.

One of the pioneers in this regard was Charles Alfred Ballance (1856-1936) of London. Ballance contributed significantly to the early development of neurosurgery and otological surgery and was knighted for his accomplishments. As noted in a recent historical perspective by Norman Horwitz,[9] Ballance was credited with a wide range of "firsts," including total excision of a cerebellopontine angle tumor with prolonged useful survival, facial nerve anastomosis in the temporal bone, and functional spinal accessory-facial nerve anastomosis (1895). Charles Ballance authored a number of books, among which is his two-volume work, Essays on the Surgery of the Temporal Bone,[3] published in 1919, which contains information that still can benefit the modern skull base surgeon.

Yet despite his many contributions, Ballance is often overlooked in historical accounts of the development of neurosurgery. Ironically, he also wrote about the history of neurosurgery.[4,5]

As noted by Horwitz, "Ballance was a year older than Victor Horsley, a classmate at the University of London, with whom he shared the gold medal award in surgery. Much of Ballance's early professional life was spent with Horsley as a colleague and coworker. Initially, Ballance conducted research at the Brown Institution in London at the time Horsley was superintendent. In 1887, he played a crucial role as Horsley's assistant when Horsley operated on Captain G- to remove a spinal cord tumor that had been clinically diagnosed by Sir William Gowers. . . ."

"Horsley's successor at Brown, Sir Charles Sherrington, who later became a Nobel laureate in physiology and medicine, was impressed with Ballance's investigative talent and collaborated with him in a laboratory study of scar formation. . . ."

"In 1891, Ballance followed Horsley in joining the neurosurgical staff at the National Hospital, Queen Square. . . . Horsley and Ballance had disparate personalities. Horsley was confident and disputatious. He involved himself in many professional and political polemics. . . . Ballance, on the other hand, was diffident and self-effacing.

"Very early in his practice, Ballance became a member of the otology department at St. Thomas's Hospital in London. Along with William Macewen in Glasgow,..., Ballance led the way in establishing the proper surgical treatment of suppurative diseases in the middle ear and their complications. He was one of the first in Britain to perform a complete mastoid operation with ligature of the jugular vein and
drainage of the lateral sinus. It was his knowledge of the pathological anatomy of the temporal bone that led to a lifelong interest in the treatment of facial paralysis.

"After distinguished service in World War I, Ballance published his monumental two-volume Essays on the Surgery of the Temporal Bone (1919). Stunning colored plates illustrating the anatomy and surgery of the cavernous sinus are juxtaposed with equally detailed pictures of the posterior fossa, showing the important relationship of the temporal bone contents to the cerebellum and draining venous sinuses. Ballance's initial knowledge of the pathophysiology of facial nerve injury and its potential for regeneration was garnered from his early experience with mastoid surgery and his extensive experimental observations recorded with Purves Stewart in a 1901 treatise, The Healing of Nerves. Some of their conclusions were invalid, particularly those related to the role of the distal segment of a divided nerve in the regenerative process. Nevertheless, many of the concepts surrounding nerve injury and healing that are accepted today were formulated a century ago. . . .

"Ballance remained interested in nerve grafts until the end of his life. He was involved in a joint investigative project with an American otologic surgeon, Arthur Duel. They worked together in New York state, conducting primate experiments on facial nerve regeneration that employed intratemporal autologous nerve grafts secured by sutureless plasma clot.

"Ballance was instrumental in the formation of the Society of British Neurological Surgeons and served as its first president. In his later years, he was rewarded with a knighthood and was the recipient of many academic accolades. These included the Lister medal, conferred on him for his distinguished contributions to surgical sciences. He shared this honor with his friend, Harvey Cushing, who invited him to be surgeon-in-chief, pro tem, at the Peter Bent Brigham Hospital in 1928. The twilight of Ballance's career was enhanced by the publication of historical papers and a book he authored on the history of brain surgery. . . ."[9]

According to Ballance,[3] the first recorded case of hypoglossal-facial nerve anastomosis was by Körte in 1903.[10] The facial nerve "was attached sideways to the hypoglossal with two fine catgut sutures."[3]

Concerning a later case reported by Tilmann in 1909, Ballance stated, "The anastomosis was made in February 1905, five months after the facial nerve had been divided. No improvement was noted for six months, then muscular tonus was to some extent regained, but no movement was observed. After nine months associated movements of the left face occurred when the tongue was moved. These movements, at first slight, gradually increased. A little later, after several attempts, the patient could move his facial muscles without moving his tongue. After two and a half years independent movement of the face was regained. The movements of the forehead and eyelids were regained last. When shown the patient could whistle, blow out his cheeks, and move the cheek to one side. He had made some progress towards regaining the movements of expression. Slight associated movements were still present. Deliberate re-education of the cortex in accordance with the new conditions is necessary to complete recovery."[3]

Although Ballance performed the procedure of spinal accessory-facial nerve anastomosis in 1895, he came to prefer using the hypoglossal nerve to restore facial function. He stated:

"The writer performed the first operation for the relief of facial palsy in 1895 after consultation with Professor Sherrington. In a letter to the writer in 1899, Professor E. A. Schäfer stated that, in his opinion, although the cortical face-centre had been cut off from its peripheral connections for a period of six months, yet it would not have lost its power to start impulses, and since the movements of the two sides
of the face are commonly associated, he would expect one face-centre to retain sufficient functional activity for both. Professor Schäfer also suggested the glosso-pharyngeal as a suitable nerve to which to attach the divided facial, on the ground that its motor nucleus is much nearer to and is apparently serially homologous with the facial nucleus. The small size of the glosso-pharyngeal and its relative inaccessibility would make this operation one of extreme difficulty.

"The writer chose the spinal accessory in his earlier operations, but now prefers and recommends the hypoglossal. The operation is not more difficult with one nerve than with the other, but the hypoglossal is to be preferred because the cortical centre for the movements of the face is more closely associated with that for the tongue than with that for the movements of the shoulder, and because paralysis of one-half of the tongue is much less inconvenience than paralysis of the sterno-mastoid and trapezius. The face-centre and the tongue-centre overlap one another, and we should therefore anticipate that the prospects of dissociated facial movement would be greater when the nerve was connected with the tongue-centre than when the connection was made with the shoulder-centre, which is much further off. Moreover, it may be recalled that the movements of the tongue are closely associated with those of the lips, so much so that in health the orbicularis oris and the transverse fibres of the tongue contract together. It is more than probable that the facial nerve derives its lip fibres from the hypoglossal nucleus. There is, therefore, a close relation, not only between the cortical face-centre and tongue-centre, but also between the facial and hypoglossal nuclei in the bulb. Even when a good result follows end to end anastomosis of the facial with the spinal accessory the study of recorded cases seems to show that recovery is much longer delayed when the spinal accessory is united with the facial than when the hypoglossal is chosen for this anastomosis."[3]

Ballance used various techniques to try to restore hypoglossal function as part of hypoglossal-facial nerve anastomosis. In 1905, Ballance used the lingual nerve to reinnervate the distal end of the divided hypoglossal nerve after using the proximal end of the latter to reinnervate the distal portion of a facial nerve that had been injured previously during the removal of a parotid tumor.[3] In 1906, he operated on a 25-year-old woman with facial paralysis, as follows.

"An incision was made along the anterior border of the sterno-mastoid; the posterior belly of the digastric was exposed and divided; the facial nerve was found at the lower part of the parotid; it was identified by direct electrical stimulation; the retrahens auris was the only muscle which contracted. The trunk of the facial was followed up to the stylo-mastoid foramen and divided at its point of emergence. The hypoglossal nerve was found and divided at the posterior border of the hyoglossus muscle. The occipital artery was divided between two ligatures, so as set free the nerve. The central end of the hypoglossal was then anastomosed with the peripheral end of the facial. The spinal accessory nerve was next isolated and split longitudinally for about two inches; one-half of the nerve was divided transversely at the peripheral end of the slit. The strip of spinal accessory so raised up was united end to end with the peripheral end of the divided hypoglossal. The posterior belly of the digastric was sutured and the wound closed. Six weeks after the operation the left trapezius and sterno-mastoid muscles and the left side of the tongue were atrophied. The patient went to Canada and so was lost sight of for some time. When she returned, eighteen months after the operation, the nutritional and functional recovery of the facial, lingual, and cervical muscles was complete. The movements of the face and tongue were dissociated, but when the shoulder was suddenly jerked a wave of muscular contraction was seen to pass from the back of the left side of the tongue towards the tip, so that the movements of the shoulder and tongue were not yet completely dissociated. . . ."[3]
By 1919, Ballance recommended "... end to end anastomosis of the facial nerve with the hypoglossal nerve, the hypoglossal being severed at a point proximal to the origin of the nerve to the thyro-hyoid muscle. The descendens noni should then be divided above the branch to the anterior belly of the omohyoid. The division of the descendens noni allows of the hypoglossal to be turned upwards to a greater extent than if it is not severed, and it meets thus the cut end of the facial trunk without tension. The proximal end of the descendens noni can then be sutured to the distal end of the hypoglossal. This anastomosis seems the most natural one to make. The nerve supply of both bellies of the omohyoid and of the sterno-hyoid and sterno-thyroid muscles would be left to the communicans cervicis nerve from the second and third spinal nerves, and this motor supply would probably become in time ample for these muscles. In two cases the writer united the peripheral end of the divided hypoglossal with half the spinal accessory, and Grant[8] united the peripheral end of the divided spinal accessory with the descendens noni."[3]

In his 1919 treatise on the operative treatment of facial palsy, Ballance[3] cited a case reported by Bevers in 1913.[6] A 14-year-old girl had had her facial nerve severed during a mastoid operation in 1910. Two and one-half months later an end-to-end hypoglossal-facial nerve anastomosis was performed. The hypoglossal nerve was cut half across and a slip 3/4 in long was raised and sutured to the peripheral end of the facial nerve.

In later years Ballance experimented with a variety of cranial nerve anastomoses.[1,2,7] He even used the central end of the divided cervical sympathetic trunk in an attempt to restore facial and hypoglossal nerve function. However, at the end of his career he concluded that a divided facial nerve should be reunited directly or with a graft rather than being reinnervated by another cranial nerve.

To quote Ballance and Duel (1932), "There can be at the present time no question as to the disability attending an anastomosis operation, and as to the imperfections present in many cases that were hailed as good recoveries in the past. . . .One of the fundamental principles of surgery, which allows of few exceptions, is that a bleeding artery must be dealt with at the site of hemorrhage. It is also a fundamental principle of surgery that an injured nerve must be operated on at the site of injury. . . .After all, it is an unnatural thing to anastomose one nerve to another, when the ideal surgical method of bringing the two ends of a divided nerve into contact, either directly or by means of a nerve graft, is both feasible and practicable."[2]

References

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