Childs Nerv Syst (2013) 29:1923–1925
DOI 10.1007/s00381-012-1978-3

CLASSICS IN PEDIATRIC NEUROSURGERY

Heinrich Bircher (1850–1923) and the first description of a surgical approach to the cavernous sinus

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Received: 5 September 2012 / Accepted: 15 November 2012 / Published online: 8 December 2012

Introduction

The cavernous sinus is a venous pathway located in the medial portion of the middle cranial fossa encircled by dural folds on either side of the sellar turcica. It contains important neurovascular structures including the cavernous segment of the carotid artery and its branches; the sympathetic plexus, the oculomotor, trochlear, and abducens cranial nerves; and ophthalmic division of the trigeminal nerve. Approaches to the cavernous sinus may be performed for basilar tip and ophthalmic segment carotid aneurysms, pituitary tumors, trigeminal neuromas, meningiomas, and other tumors in this region. Herein, we report what we believe to be the first description of surgery of the cavernous sinus.

Case report

In 1893, Heinrich Bircher, a Swiss surgeon, demographer, and military medical officer [4] (Fig. 1), reported a case of thrombophlebitis in a 25-year-old female involving the transverse, inferior petrosal, and cavernous sinuses [2]. In 1877, she initially fell ill with scarlet fever, which was complicated by purulent discharge from both ears and complete and partial loss of hearing in the left and right ears, respectively. In September of 1892, she developed fever, chills, arthralgia, severe headaches, and altered mental status. She had tenderness to palpation around the left mastoid process and neck vessels on that side. She was admitted to the local hospital in Aarau and diagnosed with *Alte Otitis interna*, *Fortsetzung der Entzuendung auf der Innenseite des Schaedels* (old internal ear infection with spread of inflammation inside the skull). Bircher's assistant, Dr. Bilger, performed a mastoidectomy and drained foul-smelling purulent material. The bony surroundings of the transverse sinus were partially destroyed and filled with pus. The wound was irrigated with Kresalol, a salicylic acid cresyl ether [12], and a dressing was applied. The patient's condition improved temporarily until the fever recurred 3 days later. She developed an oculomotor nerve palsy and pain in the distribution of the frontal branch of the trigeminal nerve followed by complete ophthalomplegia indicative of an extension of the infection into the petrous portion of the temporal bone and cavernous sinus. Given the poor prognosis, an attempt to drain more aggressively was made. In a second procedure, two burr holes were placed in the horizontal plane superior to the external auditory canal and the middle cranial fossa was opened. With a chisel and rongeur forceps, the petrous apex was carefully removed and the carotid canal exposed. The inferior wall of the carotid canal was left in place. After removal of the petrous apex, purulent material was expelled. The opening was widened and extended more posteriorly with a curette and necrotic tissue was removed with scissors and copious irrigation used. Two areas needed to be ligated because of venous bleeding. The wound was covered with an occlusive dressing. The anatomical diagnosis read *Eitrige Entzuendung des Sinus transversus von dem Punkte an, wo die Vasa mastoidea die Wand des Proc. Mast. durchbrechen, durch den Sinus petrosus inferior bis zum hinteren Theile des Sinus cavernosus* (purulent inflammation of the transverse sinus, interior petrosal and posterior cavernous

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Fig. 1 Photograph of Heinrich Bircher (1850–1923)

sinuses). The infection had obviously propagated anteriorly along the osseous–dural interface from the area of the initial operation. The fever and headache resolved immediately and due to the partial excision of the petrous bone and facial canal, the patient had a complete left-sided facial nerve palsy postoperatively. The ophthalmoplegia persisted and trigeminal neuralgia affecting the frontal and infraorbital branches of V1 and V2, respectively, persisted until the frontal branch was surgically removed in November of the same year. At the last follow up in December of that year, extraocular movements in all directions were reduced to about 50% of normal resulting in diplopia towards the end of the left eye's excursion. Complete closure of the left eyelid was not possible. The left pupil was dilated, sluggishly reactive, and accommodation was reduced. The wound was well healed and the patient returned to work as a farmer with no signs of continued infection.

Discussion

Surgical access to the cavernous sinus has a long-standing history. According to the current literature, the first cavernous sinus approaches were performed for carotid cavernous fistulas. Browder [3] in 1937 and Parkinson [5] in 1965 were the first to describe this type of operation. Since that time, the understanding of this region has evolved significantly and pioneering studies on the microsurgical anatomy were performed by Taptas [10], Dolenc [5], Umansky [11], and Rhoton [8, 13]. Cranial nerves in proximity to the cavernous sinus are important landmarks as their position exhibits little variability [10]. Discrete spaces referred to as cavernous sinus triangles in between these nerves have been characterized and serve as a safe route to gain surgical access to different parts of this region [7]. To our knowledge, Bircher's report is the first to describe an approach to the cavernous sinus. Indication for the procedure was otogenic septic thrombophlebitis of the transverse, inferior petrosal, and cavernous sinuses, an indication foreign to the modern neurosurgeon [1]. The operation was accomplished in two parts. In the first part, a mastoidectomy and performed and infectious material around the transverse sinus was removed. In the second stage, the actual cavernous sinus approach was performed through a subtemporal craniotomy. A subtemporal craniotomy will grant access to the lateral wall of the cavernous sinus but limits the ability to reach the sinus roof unless significant temporal lobe retraction is applied [8]. An approach through the lateral wall of the cavernous sinus in modern-day surgery is used for pathology involving the lateral wall such as meningiomas, trigeminal neuromas, or pituitary adenomas. Separating the outer dural layer from the inner dural layer of the lateral wall will expose the third, fourth, and fifth cranial nerves without directly opening the cavernous sinus [8]. According to Bircher's description, he encountered two sites of bleeding, potentially from injury to the inner dural layer and accidental opening of the sinus. To gain access to the inferior petrosal sinus, Bircher partially removed the petrous apex. Even though the information provided is somewhat limited, this approach appears to be most consistent with an anterior petrosectomy, which involves bone removal in the medial part of the posteromedial, or Kawase's [6] triangle and provides a corridor between the fifth and seventh and eighth cranial nerves. It enables access to pathology of the petroclival region, anterolateral brain stem, and vertebrobasilar junction [7, 8]. The facial nerve injury likely occurred during this part of the operation. Bircher also mentioned partial exposure of the internal carotid artery. Bone removal in the posterolateral, or Glasscock [9] triangle exposes the horizontal petrosal segment of the internal carotid artery.

Heinrich Bircher (1850–1923) studied medicine in Heidelberg, Germany and Bern, Switzerland. The clinic in Heidelberg later functioned as a model for the hospital where he practiced most of his life in Aurau, Switzerland. At the young age of 22, he opened his first practice in Aurau and in 1878 he presented his thesis on the surgical treatment of purulent ear infections. He also discussed the role of mastoidectomy for this indication and the danger of air

embolism from injury to a dural sinus. Astounding recoveries in patients suffering from severe otogenic infections after his surgical interventions made him famous. Bircher also made a name for himself as a teacher and researcher; particularly his abilities as a medical illustrator were reputable. Early in his career, he would frequently perform surgeries in the patient's home because he observed better wound healing in that particular environment compared to a hospital afflicted with contagious patients. With time and Lister's discoveries on antiseptic surgery, this habit became obsolete. His main area of interest was the thyroid gland and thyroid goiter, a disease endemic at that time. In 1881, in his augural lecture as a professor at the University of Bern, he reported a case of recurrent thyroid cancer he treated with resection of the neoplasm along with the larynx, thus pioneering larynx surgery. He thought an unknown agent, which he referred to as "*Miasma*", was the cause of goiter and cretinism, an idea analogous to bacteriology, and a popular field in his day. He believed that goiter was an infectious disease caused by this unknown agent that would originate in specific geological formations typical for that area of Switzerland and access the body through drinking water. Bircher's commitment was essential for the construction of the hospital in Aarau, which started in 1882. In 1887, Bircher became the administrative director of the hospital and chief of the surgical and gynecological services. Myxedema was a common complication following thryoidectomies for goiter and Bircher was the first to transplant thyroid tissue into the peritoneal cavity in an attempt to treat this condition. For example, a 33-year-old patient who had developed severe myxedema months after her thyoridectomy underwent implantation of thyroid tissue from another patient with goiter. After the operation, most of her symptoms resolved but only temporarily. Once they recurred after several months, he attempted a second transplantation, which also provided only temporary relief. Thus, in 1889, Bircher was the first to perform "*organotherapy*" [1]. Bircher also developed a technique to fixate long bone fractures with specially designed hardware and had great expertise in ovarian and gastric surgery. Bircher also worked as a physician in the military and requested that the sick bay be moved as close to the front line as possible to triage injured soldiers according to their degree of injury. He was also involved in the medical assessment of military recruits and recorded the frequency of their diseases according to the regions they were from. This demographic information led to the reorganization of regional military recruitment based on disease prevalence in specific regions instead of political aspects. Bircher was one of the first to examine the effects of gunshot wounds and his knowledge on war medicine is summarized in his book *Handbuch der Kriegsheilkunde* (Handbook of War Medicine). Bircher retired in 1917, the same year his son succeeded him as chief of surgery in Aarau, and died on June 2, 1923.

Conclusions

To our knowledge, the nineteenth century approach to the cavernous sinus by Bircher was the first of its kind. It is the pioneering efforts of such early surgeons that shape the current practice of neurosurgery.

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