Reconstruction of the cranial vault, surgical drainage of brain abscesses, and the treatment of rhinoliquorrhea: the “Luftwaffen Lazarett 6/XVII Bad Ischl,” the first neurosurgical department in Austria

Harald Stefanits, MD, PhD, Martin Aichholzer, MD, and Andreas Gruber, MD, PhD

Department of Neurosurgery, Kepler University Hospital GmbH and Johannes Kepler University, Linz, Austria

The main purpose of neurosurgery during World War II was the treatment of traumatic brain injury, injuries to the spine, and injuries to peripheral nerves—mostly penetrating injuries caused by bullets or shrapnel. After heavy bombings of Berlin, in 1943 the main neurosurgical hospital was moved to Bad Ischl, a small town in the Austrian countryside. There, Wilhelm Toennis and his successor Dietrich W. Krueger made important observations treating soldiers suffering from traumatic brain injuries. During the war and also in the postwar period, they focused on techniques for the reconstruction of the cranial vault, the treatment of brain abscesses by drainage instead of extirpation, and also the treatment of rhinoliquorrhea due to frontobasal trauma. Their approaches were sometimes contradictory to the standard of care of the times. Nevertheless, many of the principles of the techniques described are still practiced by today’s neurosurgeons.

https://thejns.org/doi/abs/10.3171/2022.6.FOCUS22257

KEYWORDS Luftwaffen Lazarett; Bad Ischl; Krueger; brain abscess; rhinoliquorrhea; cranial vault reconstruction

Neurosurgery as a science has a long tradition in Austria, originating from the Department of General Surgery at the General Hospital of Vienna in the 19th century. Famous names such as Hermann Nothnagel, Theodor Billroth, Anton Freiherr von Eisselberg, Egon Ranzi, Oskar Hirsch, and Leopold Schoenbauer are among the proponents of the Vienna neurosurgical school. However, the first hospital exclusively dedicated to neurosurgery was instituted in Bad Ischl, Upper Austria, during World War II. Heavy bombings of Berlin forced Nazi Germany to move hospitals to the countryside. Wilhelm Toennis (1898–1978), the “father of neurosurgery in Germany,” who was head of the air force medical team for brain injury, was ordered to transfer the neurosurgical unit from the Luftwaffen Lazarett 1/III Berlin-Reinicken-dorf to Bad Ischl on October 21, 1943. Three hotels were adapted to treat injured soldiers; the hotel “Kaiserkrone,” now “Luftwaffen Lazarett 6/XVII Bad Ischl,” housed a neurosurgical department, a neurological department, and a neurorehabilitation unit. In May 1945 the hospital was taken over by the US allied forces and continued to exist as “Military Hospital 901B,” with 80 neurosurgical beds on the ward in 1946. Toennis moved back to Bochum, Germany, in 1946, and Dietrich W. Krueger (1910–1965) became his successor (Fig. 1). As Pendl states, Krueger had to be “forced out of the train by the US occupation troops, as he wanted to go back to his native Berlin.”

Still under US allied occupation, the hospital was returned to the state of Austria as the “Bundesstaatliche Krankenanstalt für Neurochirurgie” (National Hospital for Neurosurgery) on February 6, 1951, and remained in Bad Ischl, which was a 37,000-inhabitant town in 1945 (there are 14,000 inhabitants today) located approximately 50 km from Salzburg and 100 km from Linz as the closest large cities (Fig. 2). On January 1, 1964, the organization was renamed “Sonderkrankenanstalt fuer Neurochirurgie” (Special Hospital for Neurosurgery). In the same year, the department of neurosurgery in Vienna was founded as an autonomous unit. After Krueger’s sudden and unexpected death in 1965, Albrecht Gund (1915–1997) took over as head of the department (Fig. 3). In 1967, 1000 patients per year were treated in the Bad Ischl hospital, and 400 surgeries were performed. Given that the Austrian constitution stated that hospitals were not to be run by state governments, but by the federal republic, the hospital in Bad Ischl was closed by December 31, 1968, and 2 neuro-
surgical departments were founded: the Departments of Neurosurgery in Salzburg and Linz were both opened to the public in the spring of 1969.

Clinical and Operative Neurosurgery in Bad Ischl During World War II and in the Postwar Period

Because Vienna has always been the center of neurosurgery in Austria, the establishment of a neurosurgical hospital in Bad Ischl in 1943 had quite an impact on the development of the specialty in Austria. Toennis and Krueger both had to focus on injuries to the head, spine, and peripheral nerves, which led to numerous publications on these issues during World War II and also in the postwar period.4–15 Neurosurgeons in the German forces could rely on guidelines on the treatment of neurosurgical pathologies. These guidelines were compiled at annual conferences that were chaired by the advising surgeon general.16

Reconstruction of the Cranial Vault (1943)

Krueger focused on reconstruction of the cranial vault and used Paladon, a polymer of Plexiglas, which was originally suggested for cranioplasty by O. Kleinschmidt in 1941. Before that, autologous implants (periosteal-cranial bone flap, tibia, rib, clavicula), silver plates, and celluloid plastics were common.13,17 Autologous implants had the disadvantages of a second surgical site, including associated risks as well as the unsatisfying cosmetic results. Silver plates on the other hand were very expensive, and celluloid dissolved camphor, one of its ingredients, which led to irritation of the surrounding tissues.17 The disadvantage of acrylic glass was that it could not be adapted during surgery given that any burring or shaping would necessitate resterilization. Either models were made of wax, or the bone flap from decompression surgery was used as a negative.

Paladon was produced by the company Kulzer und Co. in Friedrichsdorf am Taunus (near Frankfurt) in Germany and delivered as a polymer powder and a monomer liquid, which gave a shapeable mixture. Boiling the mixture in its form with applied pressure in a water bath for 40 minutes led to polymerization and hardening. From 1941 until 1943, Krueger and colleagues had implanted 18 acrylic glass flaps, and only one had to be removed due to infection. In a case of a large osteoma, an acrylic glass flap was reimplanted at the end of the surgery, which Krueger suggested for any elective surgery. A rubber drain was temporarily placed under the acrylic glass flap. In cases of traumatic etiology, Krueger suggested waiting 3 or 4 months until cranioplasty; however, after surgical site infection he insisted on an interval of 12 months. The acrylic glass flaps should be perforated in order to support healing of the implant (Fig. 4). They were fixed to the bone with wire and covered with periosteum or—if not available—fascia in order to avoid subgaleal hematoma. Cibazol (sulfonamide) was administered as peroral antibiotic prophylaxis. In the discussion, Krueger justifies this type of aesthetic surgery as “kriegswichtig” (essential to the war effort). On the one hand the patient would lose the feeling of being seriously ill, and on the other hand people at home should be spared the view of incapacitated soldiers and the frightfulness of war (Fig. 5).

Treatment of Brain Abscesses (1948, 1950)

Based on his experience with noncivilian traumatic brain injury, Krueger dedicated the postwar period to the treatment of brain abscesses as well as frontobasal injuries with rhinoliquorrhea. In 1948, he prefers abscess
drainage to total extirpation as suggested by Vincent in France in 1935. Krueger states that drainage should be performed regardless of the state of the abscess; i.e., whether it is encapsulated or not. Opening the skull to lance the abscess often results in brain prolapse due to the perifocal edema, making some kind of counterpressure necessary. Krueger refers to this concept as “immobilization of the brain.” Thus, Toennis and Krueger developed a two-stage concept: at first, a rubber sponge drainage (as suggested by Peiper) is implanted in order to sustain an elastic counterpressure. In the phase of healing of the abscess, a so-called octopus drainage tube (“Tintenfisch,” as suggested by Toennis), a rigid rubber pipe with multiple soft rubber lugs, was inserted (Fig. 6). First, a decompressive craniectomy is performed. In case of a fistula, the fistula is followed straight into the abscess formation, and the content of the abscess is aspirated. If there is no fistula, the dural opening should be minimized to the diameter of the rigid rubber pipe and the abscess is punctured transcortically. A rubber sponge is inserted into the cavity and a rigid rubber pipe that ends at the bone level drains the abscess through the former fistula. The wound is completely closed.

Before surgery, the patient is dehydrated in order to reduce brain edema, and lumbar puncture decreases intracranial pressure. Counterpressure to the brain is regulated by a compression dressing over the large craniectomy site, daily lumbar punctures, and dehydration. The rubber sponge can be aspirated via the rigid rubber pipe without having to open the wound. It is removed after a few weeks of treatment as soon as it can be pulled out easily. Large abscess cavities are further drained by the octopus drain. Frequent blood transfusions and peroral sulfonamide aid the treatment. Toennis and Krueger had treated 11 patients with this method: 2 died in the initial phase, and in 1 patient the abscess was extirpated. Among the remaining 8 patients, only 1 died due to meningitis. Krueger suggested this method also for the treatment of brain abscesses due to otitis. In 1950 Krueger published another case series of patients with brain abscess treated by drainage. He mentions that “only the cruel situation of World War II” allowed for his discoveries. He again emphasizes that extirpation of the brain abscesses in his cases would have caused neurological deficits and that mortality in 14 patients could be reduced to 21.3%. Krueger insists on preserving the vital brain tissue covering the abscess—contrary to Sunder-Plassman, who supported resection of this tissue.

**Treatment of Rhinoliquorrhea (1951, 1952, 1958)**

In contrast to the opinion of many neurosurgeons at the time, Krueger was in favor of the surgical treatment of nontraumatic and posttraumatic rhinoliquorrhea within 6–8 days. Any signs of infection shortened this interval. Antibiotics (penicillin, sulfonamide) aided in the treatment. An extradural approach should only be performed when the localization of the fistula is defined, and it is lo-
**FIG. 5.** A: Facial plaster model of a 42-year-old soldier with a frontal bullet wound. **B and C:** Defects before cranioplasty were disfiguring. **D and E:** Cranial vault reconstruction was performed on October 12, 1945, at Military Hospital 901B, Bad Ischl. Courtesy of Oberösterreichisches Landesarchiv.

**FIG. 6.** Treatment of a cerebral abscess in a 25-year-old soldier. **A:** Tintenfisch (octopus) drainage was inserted on July 19, 1944. **B:** Relapse of the brain abscess after successful treatment (date unknown, Luftwaffen Lazarett 6/XVII Bad Ischl). Courtesy of Oberösterreichisches Landesarchiv.
cated in the vicinity of the frontal sinuses. All other situations favor an intradural exploration, if necessary bifrontally, including resection of the falx. Closure of the fistula is maintained by a periosteal flap or fascia lata, but only at the convexity or the anterior third of the frontal skull base. The dura mater in the middle and posterior third of the frontal skull base is thin and the flap cannot be fixed by suture. Thus, Krueger suggests a fascia-muscle tamponade. The fascia is sutured to the dura in the anterior part and pushed extradurally toward the sella over the dural defect. The adjacent muscle tamponade fixes the flap in its position. The dural defect itself is closed whenever possible.

The mucosa is removed from the fractured frontal sinus and the nasofrontal ducts are tamponaded with muscle. Whenever the lamina cribrosa or the ethmoid is fractured, a strip tamponade is placed close to the aforementioned fascia-muscle tamponade and channeled through the skin next to the eyebrow. This technique ensures a faster granulation of the tissues. The tamponade is removed as soon as it can be pulled out easily.

Krueger concludes that a conservative approach may be maintained for a maximum of 8 days. However, he revised this time period in a manuscript from 1958, in which he suggests immediate surgery in idiopathic and traumatic rhinoliquorrhea (unpublished work). Surgical treatment consists of localization of the fistula by an extra- or intradural approach; closure of the fistula, which differs in the anterior, middle, and posterior third of the anterior cranial fossa; and evaluation of the relation to the paranasal cavities.12

Conclusions

“Only the cruel situation of World War II,” as Krueger states in one of his publications, made his experiences with the reconstruction of the cranial vault, the treatment of brain abscess, or rhinoliquorrhea even possible. Modern neurosurgery was only at its beginning: antibiotics were not available for Germany’s neurosurgeons until neurosurgery was only at its beginning: antibiotics were not available for Germany’s neurosurgeons until 1946. The expertise they gained during the war for the treatment of neurosurgical patients for the postwar era. They made important observations on the natural course of disease and developed techniques that are—at least in outline—still practiced by today’s neurosurgeons.

Acknowledgments

We thank Johannes Eberl (Ischler Heimatverein) for providing two articles on the Kaiserkrone Bad Ischl; Peter Eigelsberger (Documentation Center Hartheim) for helping with researching the estate of D. W. Krueger, which is archived by the Upper Austrian Federal Archives; and Guenther Stefanits for critical discussion on the historical contents of this paper.

References

5. Toennis W. Wann sollen die Schußverletzungen der peripheren Nerven operiert werden? Der Deutsche Militärarzt; 1943.

Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Stefanits, Aichholzer. Acquisition of data: Stefanits, Aichholzer. Analysis and interpretation of data: Stefanits. Drafting the article: Stefanits. Critically revising the article: Aichholzer, Gruber. Reviewed submitted version of manuscript: Aichholzer, Gruber. Approved the final version of the manuscript on behalf of all authors: Stefanits.

Correspondence

Harald Stefanits: Kepler University Hospital GmbH and Johannes Kepler University, Linz, Austria. harald.stefanits@kepleruniklinikum.at.