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**Adolf Bingel, the second inventor of lumbar pneumencephalography.**

J Möller, M Hermes and U Piepgras

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# HISTORY

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## Adolf Bingel, the Second Inventor of Lumbar Pneumencephalography

Jürgen Müller, Manfred Hermes, and Uwe Piepgras

More than 20 years had to pass until the x-rays discovered in 1895 by Röntgen in Würzburg made visible the interior of the skull by outlining the inner and outer surfaces of the brain. A pioneer in this field was the American Walter Dandy, who in 1918 was the first to inject air into the lateral ventricles through a burr hole. Although in 1919 he reported eight pneumencephalographies after lumbar air insufflation, he stayed with direct ventriculography because he was afraid of possible complications (1, 2). Stimulated by Dandy's paper of 1919, the Norwegian Sofus Widerøe stepped into the field of encephalography shortly thereafter. In 1921 Widerøe published 11 cases of patients with spinal diseases in whom he used the spinal pain caused by lumbar air injection as a means of segmental identification of spinal tumors. He succeeded in demonstrating several intracranial air bubbles but failed to show the ventricular system or the spinal subarachnoid spaces (3).

At the same time as Widerøe, the German internist Adolf Bingel (Fig 1) in Braunschweig transferred his experiences from air insufflation into joints and the peritoneum to the central nervous system. It was an accidental observation that led Bingel to encephalography when he saw an air bubble in the lateral ventricles of a patient who had undergone lumbar puncture on the preceding day (4). Contrary to Dandy and Widerøe, Adolf Bingel learned from this observation. He proceeded to ventricular imaging, improved the technique of lumbar puncture, and did a scientific evaluation of the results.

Bingel started with cadaver experiments in which he could see air penetrating into the cra-

nial subarachnoid space and into the ventricles. He then increased the amount of insufflated air to 40 to 50 cm<sup>3</sup> in the sitting patient and made x-ray exposures in frontal and lateral views. He demonstrated that the foramina medialis (of Magendie) and lateralia (of Luschka) of the fourth ventricle were physiologically open and that the ventricles could communicate with the spinal cerebrospinal fluid (CSF) (5).

Bingel performed his first lumbar encephalography in 1919. Dandy's papers were unknown to him at this time, as he wrote later. They were not accessible to him before he himself published in detail his elaborate procedure in volume 28 (1921–1922) of the journal *Fortschritte auf dem Gebiete der Röntgenstrahlen* (*Advances on X-ray Applications*) (6, 7). He presented his first results on January 31, 1921, during a meeting of the local medical assembly at Braunschweig, Germany. In this paper he described the technique and the detailed results of his procedure based on his experience with 40 patients. For the lumbar air insufflation in the sitting patient he developed a special instrument (Fig 2), which guaranteed that the amount of drained CSF exactly equaled the amount of injected air and that the CSF pressure remained constant. He thought this to be an important precondition to avoid side effects. Bingel refined his procedure constantly. In the years after 1922, he reported more than 100 cases.

From 1921 to 1929 the investigation of encephalography, the methodological development, and the clinical applications were the center of Adolf Bingel's work. During this time he published improvements of the injection apparatus for air insufflation, hints for the segmental localization of spinal processes by air insufflation, and the therapeutic advantage of encephalography, as well as the side effects, including two cases of death (8–12). Bingel gave exact instructions on how to carry out

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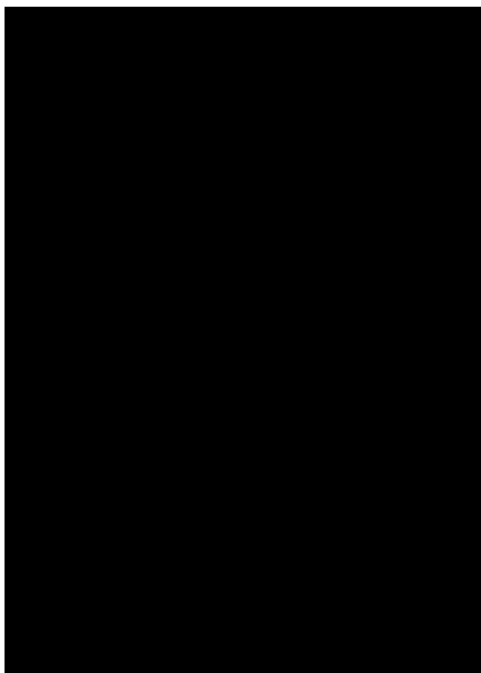


Fig 1. Adolf Bingel, 1879–1953.

encephalography using the apparatus developed and improved by him. In 1922 he believed that his apparatus could keep the intradural pressure constant enough to avoid the usual risks of CSF drainage in tumors of the posterior fossa (10). However, several deaths caused Bingel later to dissociate himself from this concept and to prohibit encephalography in cases of suspected cerebellar tumors (13, 14).

Several review articles published between 1927 and 1929 (15–19) summarized his comprehensive experience in demonstrating the CSF spaces by air. He emphasized the equivalence of Dandy's direct ventriculography and his preferred lumbar route as well as the suboccipital technique of air insufflation and listed indications and risks of each method. Among early side effects he observed with his method were headache, vertigo, nausea, vomiting, and collapse. Late effects did not occur. One risk he observed was overestimation and misinterpretation of the results, but this he thought to be attributable to the investigator and not to the method.

Born on February 19, 1879, in Koblenz, Germany, the son of a coal and wine merchant and of the daughter of the publisher Karl Baedeker, Adolf Bingel enrolled at age 18 at the University of Tübingen for medicine during the winter semester 1897–1898. In 1902 he passed the final

examination and accompanied several voyages to North America and East Asia as a ship's doctor. On his return, Bingel began work in April 1903 as an assistant with Marchand in Leipzig and from 1904 to 1906 with Ernst von Romberg, first in Marburg and then in Tübingen. Only 27 years old, Bingel had already developed a sphygmometer, a combination of sphygmography and sphygmomanometer, which allowed more exact determinations of diastolic blood pressure (20). The papers, "Diabetes" (4), "Influence of Beer Drinking and Fencing on the Hearts of Young People" (4), and "Measuring Blood Pressure in Man" (4) followed. Later, during his tenure as head physician in Frankfurt, he and Lühje undertook animal tests of renin, which had been discovered in 1898 by Tigerstedt and Bergmann. Strauss and Bingel (21) referred to the probable protein nature, the peripheral arterial point of attack, the different time and duration of activity compared with adrenalin, and the tachyphylaxia of renin. They also emphasized the role of renin in connection with concomitant hypertension and kidney disease (22).

When Alfred Schwenckenbecher took over from Lühje as principal in Frankfurt in 1910, Bingel, at age 31, was made head physician of the Medical Department at Braunschweig Hospital. Here important papers emerged with top-

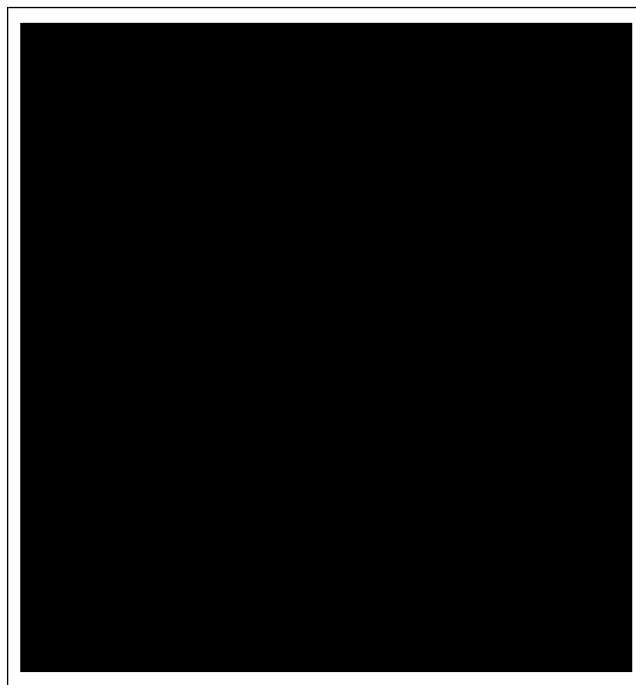


Fig 2. Bingel's apparatus (from Bingel [6]).

ics that demonstrated the comprehensive range of the clinician: monocytic leukemia (4), salvarsan therapy and encephalitis (4), polyneuritis (4), pituitary tumors (4), and Biermer disease (pernicious anemia) (4). He became a trailblazer in the technique of liver biopsy. He himself did more than 100 liver biopsies and evaluated them scientifically (23). By introducing preoperative determination of bleeding time, administration of laxatives the evening before, empty stomach, and the injection of euphyllin or hemosistan, respectively, he reduced the lethality of this intervention. More than 150 tracheostomies and one direct cardiac puncture confirm the practical skill of the radiologist, internist, and neurologist Bingel. Regarding the indication for abortion in diabetics, Bingel in 1912 differed and repeated in 1927 (4) that therapy of the diabetes is usually sufficient to maintain pregnancy. This opinion was confirmed by healthy children delivered without complications in the meantime.

After a period of very intense research during the 1920s, there were only a few papers published by Bingel in the 1930s. He demanded a passport photo from every patient whom he had exposed in his hospital, together with the routine x-ray of the thorax as well as a handwriting specimen for the medical record. Both he thought of greater value than long-winded descriptions. As a concession to the prevailing ideology, Bingel wondered whether brown eyebrows had to be interpreted as a racial mark (24).

During the years of World War II, Bingel came back to his paper about diphtheria antitoxin, which in 1918 was widely rejected (25). In this comprehensive, randomized, blindly evaluated study of 1000 patients with diphtheria, Bingel could not detect a superiority of the antitoxin to a common control serum and confirmed this with a control study of almost 3000 patients during the years 1941 to 1943 (26, 27).

Until 1948, a total of 38 years, Bingel worked as head physician in Braunschweig and continued his scientific work beyond his term of office. Despite several political and social restructurings, Bingel had outlasted two world wars, the Weimar Republic, and National Socialism as head physician of the Braunschweig Medical Hospital (28). He died at age 74 on May 16, 1953.

Although Bingel was an internist, the refinement of lumbar pneumoencephalography was

probably his most important contribution to medical science. This method remained one of the most useful tools in neuroradiology until the advent of computed tomography during the 1970s.

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