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Guido Nikkhah · Marcus Pinsker
Editors

Stereotactic and Functional Neurosurgery

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Foreword

More than 60 years ago, Traugott Riechert, Max Wolff, and Fritz Mundinger inaugurated a new targeting device for intracerebral interventions which later became world- famous as the *Riechert–Mundinger stereotactic system*. This was the basis for an important development in the history of stereotactic and functional neurosurgery. One of the first milestone operations with this system was performed on November 14, 1952. During this day, the Freiburg team performed for the first time in the history of medicine a neurosurgical operation by stereotactic means to lesion a deeply seated nucleus of the basal ganglia. It was Fritz Mundinger who performed this surgery in the presence of Wolf Hassler, Traugott Riechert, and R. von Baumgarten on a 38-year-old man who suffered from Parkinson's disease with severe tremor. It was the first thalamotomy, and marks an important date in the history of functional neurosurgery for movement disorders.

From this time on, stereotactic and functional neurosurgery have evolved into a fascinating and interdisciplinary endeavour that combines modern neurosurgery, neurobiology, and neuroimaging with innovative diagnostic and treatment strategies. During the International Congress on the occasion of the 60th Anniversary of Stereotactic and Functional Neurosurgery in Freiburg, we celebrated these pioneering and outstanding achievements with a series of lectures that were given by the different generations of neurosurgeons, including the fathers of modern stereotaxy, among them Philipp Gildenberg and Ronald Tasker. During the 3 days of the Congress from December 1 to December 3, 2011, a great international audience were able to witness the ground-breaking and exciting journey that pioneers in stereotactic and functional neurosurgery have undertaken until today to conquer the challenges imposed by the diseases of the human nervous system, such as pain, movement disorders, brain tumors, and psychiatric diseases.

Following this 60th Anniversary Meeting of Stereotactic Neurosurgery in Freiburg, a number of authors were invited to contribute to this dedicated volume of *Acta Neurochirurgica*. I am very happy that 16 authors have compiled their scientific and clinical experience in stereotactic and functional neurosurgery, in movement disorders, and in brain tumors. The scientific contributions present a wide range from the beginnings of human stereotactic neurosurgery to the most modern molecular and restorative strategies to treat diseases of the human nervous system. They also clearly exemplify that the discipline of stereotactic and functional neurosurgery is still a young and dynamic discipline, with alternative and sometimes competing neurosurgical and functional neurosurgical strategies that are still under further evaluation. They also document that operative lesioning techniques such as thalamotomies have been succeeded by novel neuromodulation techniques such as deep brain stimulation in the great majority of clinical cases. However, under some circumstances, the older techniques have still their place in modern functional neurosurgery.

Anyone who is further interested in the specific circumstances of the development of the Department of Stereotactic and Functional Neurosurgery in Freiburg over the 60 years is referred to the book that was published under the title "Journeys to the center of the brain" by Guido Nikkhah in collaboration with Julia Bidder and Walter Birg.

It is my special privilege to thank all the authors and co-authors of this volume for their valuable scientific contribution. I want to express my sincere gratitude to my co-workers Marcus Pinsker, Thomas Reithmeier, Michael Trippel, and Thomas Prokop for their invaluable help in the review of the manuscripts as well as in the editorial work. A big thank you belongs to Manuela Fellmann who supported me during the preparation of this dedicated volume. Many thanks belong to the European Society for Stereotactic and Functional Neurosurgery, the staff members of Acta Neurochirurgica, especially the editor Hans-Jakob Steiger, all of whom were very helpful and supportive in the finalization of this project. Last, but not least, I am especially thankful to the Sponsors of the Anniversary Meeting for their invaluable financial contribution, and among them especially to the Medtronic company which, in addition, financially supported the publication of this dedicated volume.

I want to dedicate this supplement volume to Fritz Mundinger who died at the age of 87 on May 23, 2012. His clinical and scientific contributions laid an important ground in my own career in stereotactic and functional neurosurgery. I had the privilege to learn from his sharp and brilliant mind and clinical skills over many years, and I truly enjoyed the intense personal discussions I had with him over all these years, even until a few weeks before he died. His contributions to stereotactic and functional neurosurgery will remain a major hallmark for many generations of young neurosurgeons to come, and the present volume of *Acta Neurochirurgica* is a fine example of his unique inheritance. May it direct our attention to the right "targets" during the further progress of this exciting and fascinating journey towards the human brain and its best treatments for our patients.

Freiburg, July 17th, 2012 Guido Nikkhah

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The Birth of Human Stereotactic Surgery

Philip L. Gildenberg

Abstract Stereotactic surgery began with the Horsley–Clarke apparatus which has been used in animal research since 1908. In 1947, Spiegel and Wycis introduced stereotactic surgery in human patients. Their initial choice of target involved the extrapyramidal system, which Russell Meyers had recently performed with craniotomy and manual lesions that might alleviate symptoms of movement disorders, albeit with significant morbidity and mortality, a problem not seen with stereotactic surgery.

Keywords Cartesian coordinates • Extrapyramidal system • Horsley and Clarke stereotaxic apparatus (animal research) • Huntington's chorea • International Society for Research in Stereoencephalotomy•Pallidotomy•Pneumoencephalographic landmarks • Psychosurgery • Russell Meyers • Spiegel and Wycis stereotactic apparatus (human patients) • Stereotaxic surgery • World Society for Stereotactic and Functional Neurosurgery

Animal stereotactic surgery pre-dated human stereotactic surgery by almost 40 years. Why did it take so long to apply this accurate minimally invasive technique to human patients? To find the logical explanation, it is necessary to look at the state of several arts that came together at just the right time — advances in knowledge of physiology of the nervous system, a desire to perform a discredited neurosurgical procedure with accuracy and better patient selection, and advances in radiology that made it possible to identify landmarks in the brain from which accurate target placement could be defined.

The birth of animal stereotactic surgery occurred in 1908, when Horsley and Clarke [1] reported on a device for inserting a needle or electrode accurately into a desired structure in the monkey brain. The animal's head was secured by two ear plugs and by two tabs that held the inferior orbital rims; thus, the ear plugs assured accurate alignment with the midline. The orbital tabs held the head in a reproducibly accurate position. The three planes which formed the Cartesian planes were the midplane, the basal or horizontal plane that passed through the ear plugs and the orbital tabs, and the zero coronal plane that formed right angles to the other two planes and passed through the ear plugs. In the material and methods section of the landmark article, the Horsley and Clarke not only described the stereotactic apparatus but a method to make a stereotactic atlas. The description of forming a reproducible electrolytic lesion in itself was a significant contribution. To conclude on a high note, there was a study of the physiology of the cerebellum of the monkey.

Since localization of the target was dependent on the configuration of structures in the skull, which are consistent within each breed of experimental animals, accurate placement was almost assured. In addition, localization was verified by sectioning the brain when the animal was sacrificed, and data from unsatisfactory placement could be discarded.

It was fortunate that they did not use that type of device on human patients, since they recognized that the human skull is much too variable to assure an accurately placed target. An engineer, Mussen, did, however, design and produce a prototype according to the dimensions of the human head. Fortunately, he did not find a surgeon to use it clinically. The error would have been so great that it might have set back the development of stereotaxis even further.

What were some of the intellectual impediments to the development of human basal ganglia surgery between 1908 and 1940? In 1940, it was thought that surgery on the basal ganglia would cause permanent impairment of consciousness. This was based on assertion by Dandy [2], on observation of two patients, that occlusion of the left anterior cerebral artery and the distribution of the resultant cerebral damage caused permanent loss of consciousness (although his description is

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