Techniques in Epilepsy Surgery

The MNI Approach

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Acknowledgment

This book is principally dedicated to the memory of Dr. Theodore Rasmussen who for 30 years maintained an active practice in the surgery of epilepsy at the Montreal Neurological Institute (MNI). A disciple and successor to Penfield, Rasmussen was a master brain surgeon with exquisite surgical techniques. He was not only a remarkable technician but also an outstanding clinician, radiologist, and epileptologist. How he could maintain a busy surgical practice and fulfil his administrative duties as director of the MNI and department chairman can only be explained by an exceptional sense of organization. Many of the techniques discussed in this book, especially the subpial dissection technique were transmitted by Theodore Rasmussen to those who had the privilege of working with him.

This book is also written in memory of Dr. William Vernon Cone, neurosurgeon and neuropathologist who played such an important role in the development of neurosurgical techniques at the MNI. He was responsible for the Department of Neuropathology and established strong guidelines for patient care.

The authors also want to pay tribute to several colleagues who played an essential role in our epilepsy surgical program.

To Dr. Pierre Gloor who contributed so much to the weekly seizure conferences where he discussed the more fundamental neurophysiological aspects of epilepsy as they applied to clinical situations. He also played an essential role in the study of patients implanted with intracranial electrodes by defining the electro-clinical correlation of seizure discharges and by documenting and interpreting the responses to electrical stimulation.

To Dr. Frederick Andermann, director of the epilepsy clinic, who has been an indefatigable coworker, with an extraordinary clinical acumen. More than any other neurologist, Frederick Andermann has been an unbiased supporter of the surgery for epilepsy. His contributions have been enormous and important such as the recognition of various types of cortical malformations on MRI and their potential as surgical entities.

To the late Felipe Quesney and to François Dubeau who with Pierre Gloor have also played an essential role in the interpretation of the intracranial recording studies and electrocorticography. Eva Andermann has also contributed over the years with the peroperative electrocorticography. To John Ives who developed the automatic seizure detection computer program and to Jean Gotman for his expertise in recording the electrical activity of the brain.

To the neuropsychologists: Dr. Brenda Milner, Mr. Laughlin Taylor, Dr. Marilyn Jones-Gotman, Vivian Ziklas, Joelle Crane, and Dr. Denise Klein for their enthusiasm and unaltered efforts to define patients' neuropsychological profiles. The role played by the neuropsychologists in the evaluation of epilepsy surgery is absolutely essential by defining the psychometric profile of each patient preoperatively and alerting the surgeon about potential cognitive pitfalls related to specific surgical modalities.

To Terry Peter, Bruce Pike and the numerous fellows in the Brain Imaging Center who have helped so much with our program of image-guided surgery. This started with the incorporation of CT scanning for stereotactic mapping but rapidly evolved to the first use of digital angiography in stereotaxy to the development of the first MRI compatible stereotactic apparatus.

To Eddie Puodziunas and Vaclav Tipal and his son Peter and later to Brian Hynes for their help in the development of numerous surgical tools and instruments. With the Tipals and Terry Peters and Gilles Bertrand we developed the first MRI-compatible stereotactic apparatus which was used mainly for the placement of intracranial electrodes in patients with intractable epilepsy. With Brian Hynes we developed the first frameless stereotactic apparatus (Free Guide) which is now used routinely in the placement of intracranial electrodes. To Lahbib Soualmi who helped

to develop the Neuronavigation Unit and to Kelvin Mok who has followed in his footsteps with the assistance of the navigation technicians, Manny Podaras and Richard Barecki. Not to be forgotten are members of the Neuro-Photography Department The late Charles Hodge, Marcus Arts, and Helmut Bernhard.

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To my secretaries, Monika Malecki and Luisa Birri who for so many years have helped with the care of patients and with the documentation of our surgical experience. They were in large part responsible for the pre- and postoperative follow-up of all the patients. To my wife, Nicole, for her support and help with the organization and computerization of the database and follow-up. She has been responsible for creating and updating the computer data grid and the patient follow-up. To my son Frederic who has helped with many of the illustrations.

To the many residents and fellows who over the years have contributed so much to the development and improvement of some of the surgical techniques. Every single one, by adhering to the techniques described in this book, has also contributed to maintain a low surgical morbidity and helped to bring relief from seizures to several hundreds of patients.

Finally, to all the patients with epilepsy and their families. We have learned much from these patients and their parents. Patients with intractable epilepsy have learned early in life what adversity is all about and in most instances are extremely motivated to participate actively in their surgical treatment and to improve their quality of life. The families of the patients have always been most dedicated, helpful and supportive of the medical team.

I would also like to express a special word of gratitude to two great mentors, Dr. Louis Poirier and Dr. Herbert Jasper. Louis Poirier was responsible for triggering and stimulating my interest in neuroanatomy while I was a medical student at the University of Montreal and later a Ph.D. student in his laboratory at Laval University. In the early 1960s Louis Poirier together with Theodore Sourkes were directly involved in the discovery of the dopaminergic nigro-striatal pathway, a seminal event in the history of neurosciences. To Herbert Jasper not only for his colossal input to the understanding of epilepsy and for his important role in the development of epilepsy surgery but on a more personal basis for his sustained interest over the years for my thesis work on the intralaminar nuclei of the thalamus.

André Olivier MD, PhD
Theodore Rasmussen (1910–2002)
Former Neurosurgeon-in-Chief and MNI director

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Preface

By the year 2005 the senior author had carried out over 2500 surgical procedures for the treatment of intractable epilepsies. The procedures were all carried out at the Montreal Neurological Institute and Hospital. Most of the surgical approaches and techniques of brain mapping and cortical resections were taught to me by Theodore Rasmussen. I was fortunate enough to practice neurosurgery during a period which saw dramatic improvement in neurosurgical techniques, namely microsurgery and image-guided surgery. Most of the microsurgical techniques had been applied to extracerebral vascular and tumoral lesions. We made a constant effort to apply these techniques to the intragyral endopial resection. In 1992, we started applying neuronavigation to virtually all procedures for epilepsy from preoperative brain mapping to intracranial recording and various types of cortical resections.

The book is mainly concerned with surgical techniques in epilepsy and reflects the authors' bias concerning the importance of mastering the trilogy of topographic, vascular and functional anatomy of the brain. It is not only a book on surgical techniques but also a guide for neurosurgeons who specialize or will specialize in that field. I like to think of it as a manual for the Fellows in Epilepsy Surgery, to help them understand in a practical way the basic anatomical and physiological mechanisms of epilepsy and the clinical seizure patterns leading to the surgical hypothesis. The best surgical techniques will only be effective if applied to well-selected patients with sound indications. The neurosurgeon must be familiar with all the investigation techniques and especially those of intracranial recording and stimulation. He must develop consultant skills; skills in evaluating the patient, not only as a surgical candidate but as an individual overwhelmed by the occurrence of seizures who could have false expectations of surgery. He must develop skills in teaching basic anatomy to patients and their families for their own understanding. The neurosurgeon must develop also a technique for database collection for each patient where the essential of his history and investigation are gathered and fully analyzed before any decision to operate is reached. This will go a long way to avoid pitfalls which can result not only from lack of knowledge of surgical anatomy and poor surgical techniques but also from inadequate patient selection.

The neurosurgeon as a consultant must be able to discuss with the epileptologist, the neuropsychologist, and the radiologist in practical terms. He must be able to establish his own view and recommendations, based on the history, neurological examination, and cerebral imaging. One of his main responsibilities is to evaluate the pertinence and feasibility of a surgical procedure and of course to participate in the decision process for or against surgery. He remains the best person to evaluate the morbidity of special surgical interventions. His indication for surgery must reside on a sound working hypothesis about the site of seizure onset. He must have in mind at all times some of the pitfalls of surgery such as wrong diagnosis, irrelevant lesions, false identification of functional areas, and the eventual impact of surgery on memory, speech, motor function, and vision.

There has been a continuous growth of interest in the surgery of epilepsy over the last three decades and this is the result of several factors. The development of modern recording techniques and especially that of computer seizure detection combined with video monitoring by John Ives around 1971 was a major breakthrough.

The advent of MRI around 1985 brought a revolution in the field of epilepsy surgery. Its many modalities have revealed a large variety of epileptogenic lesions and their topographic relationships to eloquent areas of the brain. Traditional neuroradiology based on skull X-rays and pneumoencephalography was eventually replaced by a multiplicity of imaging modalities such as MRI and PET scanning, fMRI and spectroscopy. Another considerable impact of high-resolution

imaging of the brain was the advent of neuronavigation. By combining computer-image guidance to microsurgical technique virtually any epileptogenic lesion in any area of the brain can now be considered for safe resection.

The emergence and development of comprehensive epilepsy centers brought a consolidation of the notion of a multidisciplinary team approach in the investigation and treatment of epilepsy. Neurologists and clinical neurophysiologists have become more involved in detecting the site of onset of seizures and in searching for the causative lesion.

Furthermore, there has been a progressive change of attitude among neurologists and epileptologists who realized more and more that epilepsy cannot be cured by anticonvulsive medication and that too often seizure control is obtained at the cost of unacceptable side effects which often affect quality of life as much as the occurrence of seizures themselves.

The ultimate goal of epilepsy surgery is to improve the patient's quality of life and restore his or her self confidence. This can now be accomplished in a larger and larger percentage of patients, by combining the theory and practice of surgery, i.e. knowledge and practical wisdom on the one hand and sound surgical techniques on the other.

Hopefully this book will help fulfill these expectations.