Plastic Neurosurgery

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Editors

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Opening and Closing Neurosurgical Doors in Adults and Children

Springer

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This book is dedicated to my wife Susan Huba Winston, who supported me in my professional endeavors, encouraged me when I was down, tolerated my idiosyncrasies, and enriched my life immeasurably. The book is also dedicated to the neurosurgical residents from whom I learned so much.

Preface

In a serendipitous encounter in 1963, with Dr. Eustace Semmes, professor of neurosurgery at the University of Tennessee, he queried me, a senior medical student, on lumbar nerve syndromes, and said, as I was departing was, that I should consider becoming a neurosurgeon. I gave little thought to this and only recalled it years later. After considering a career in neurology, completing a medical internship, and spending 2 years in the US Public Health Service, first assigned as a psychiatrist in a US Public Health Hospital for narcotic addicts, 5 months on a ship surveying the northern Pacific Ocean floor, and 7 months in a general medical and leprosy clinic, I decided to become a neurosurgeon. Those who had strong guiding influences in my professional career and growth included Professor Keasley Welch, my neurosurgical mentor, and Professors Joseph Murray and Paul Tessier, who introduced me to plastic surgery and to the world of craniofacial surgery. During my conversational and surgical experiences with these surgeons, I was profoundly impressed and humbled by their professionalism, depth of knowledge, pursuit of perfection, attention to details, and how much they enjoyed helping people.

I too enjoyed my practice of neurosurgery and almost never felt that I was working. I love the science, art, and history of neurosurgery, and I have experienced no greater pleasure than getting to know patients and their families. Patients have shared intimate and often convoluted histories of suffering, fascinating tales of adventure, success, misfortune, crime, and painful-to-hear violence. I strove to understand and relieve their suffering and improve the quality of their lives. My life as a neurosurgeon has been and continues to be an immensely rewarding and enthusiastically enjoyed adventure—well, not every minute!

During years of participation in and supervision of neurosurgical mortality and morbidity (M&M) conferences, I became progressively more aware that many avoidable complications have their roots in the opening and reconstruction phases of neurosurgical interventions. A large proportion of these complications arise from lack of attention to the detailed management of skin, bone, and dura. Over several decades, I repeatedly revised an ever-changing and expanding outline of information and ideas that I thought would be beneficial to trainees, practitioners of neurosurgery, and especially their patients. Professor Kevin Lillehei encouraged me to write or edit a book on these concepts.

Because of the routineness and perceived simplicity of the opening and closing of neurosurgical operations, plastic surgical components receive little directed

attention in standard neurosurgical training. Often, the neurosurgical opening may be efficiently executed by the attending surgeon, and the reconstruction and closure by a trusted but less experienced member of the surgical team.

All neurosurgeons, particularly in the formative years of their residencies and fellowships, should learn and never forget not only the *what* and *how* but also the *why* of the plastic components of neurosurgery. Much but not all of this information exists in written form that is scattered through decades of texts and journals on neurosurgery, plastic surgery, basic science, and general surgery. This information is apparently thought to be self-evident or trivial, and because there exists no neurosurgical text or journal that is devoted to or significantly inclusive of this subset of neurosurgical knowledge, it is not always specifically taught or well learned. Many of the practical details and nuances exist as psychomotor skills possessed by experienced expert practitioners.

The execution of plastic neurosurgery is generally uniform around the world, but there is variation among experts with regard to details, as some will recognize in this book. These variations reflect well-reasoned steps that have sound physiologic bases and, like those described in this text, have proven to be successful in the hands of these surgeons. A junior trainee may occasionally attempt to improve an established routine or technique by altering or omitting a component. The consequence is often a complication. The most dangerous surgeon is an "innovative" junior resident.

The surgery of nonneural tissues receives almost no focused attention in the training of neurosurgeons, beyond what may be discussed during surgeries and in M&M conferences. Surgical ideas and skills—good and not so good—have been informally passed along over millennia by observing, interacting with, and imitating experienced practitioners. Similarly, trainees today learn the opening and closing phases of neurosurgery from mentors, which include academic neurosurgeons, fellows, and more senior residents, through a regimen of observation, interaction, imitation, and gradually released responsibility. The nitty-gritty details of the opening and closing of doors for neurosurgery tend to be learned by rote. The levels of understanding and technical expertise among mentors vary with respect to technical details, healing, and cosmesis.

Clearly, there is a need for a neurosurgical source that is focused on the details of the opening and closing phases of operations, rather unlike existing excellent neurosurgical journals, texts, and atlases, which are scholarly weighted on the management of neural tissues.

The management of disorders of the central and peripheral nervous tissues has vastly improved, especially in the most recent 50 years, as a result of advancements in the understanding of physiology and pathology, better diagnostic and surgical tools, and improved techniques. The neurosurgical management of skin, bone, dura, and muscle has undergone slower evolution across the same span of time.

This book is both descriptive and prescriptive of skills and techniques with the recognition that all attempts to achieve perfection or to set specific surgical techniques are doomed before the printer's ink dries, due to the unpredictability, magnitude of force, and benefit of relentless change. Surgeons, in executing operations,

teaching, and writing, should be humbled by two fundamental rules of human nature: mistakes are inevitable and we cannot escape our biases, particularly the most dangerous ones which are those we do not recognize [1]. It is important that neurosurgeons do their best for each patient, continually strive to improve, be good teachers, and pay attention to details.

The great Finnish architect, Eliel Saarinen, like many artists at the turn of the nineteenth century, felt that work, art, and life should be an indivisible whole [2]. Never may a surgeon who does not embody these characteristics and who does not enjoy what he or she does perform surgery on me or any member of my family.

1. Michael Lewis. *The Undoing Project.* WW Norton & Company; 1999
2. Hausen M, Mikkola K, Amberg A-L, Valto T. *Eliel Saarinen: Projects 1896–1923.* First MIT ed. Cambridge MA,: MIT Press; 1990

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I also acknowledge Dr. Kevin Lillehei, professor and chairman of the department of neurosurgery, who encouraged me to compose my ideas on neurosurgical techniques and approaches in the form of a book.

Introduction

This book describes the crucial and undertreated intersection of neurosurgery and plastic surgery and is co-edited by a neurosurgeon and a plastic surgeon with over 75 years of combined experience. It is a topically organized treatise that is both descriptive and prescriptive and is intended as a guidance for residents, fellows, and practitioners in all neurosurgical subspecialties.

Every non-radiosurgical procedure has three distinct phases. Phase one consists of opening a door to a neurosurgical target, which always requires the infliction of damage to nonneural, usually healthy tissues. Phase two is the execution of the surgical mission and involves neural tissue. The third or restorative phase consists of closing the surgical door by repairing the damage done in phase one, with attention to wound healing, prevention of complications, and cosmesis. Neurosurgery thus has two distinctly different major components: (a) phases one and three, which are confined to surgery on nonneural tissues, and (b) phase two, which is surgery on neural tissues. The knowledge base, skill set, surgical techniques, and many of the instruments required for the opening and closing phases are vastly different from those required in phase two. In addition, the risks and types of complications for phases one and three differ greatly from those of the middle phase.

The opening and reconstructive closing phases require detailed knowledge of the micro- and macro-characteristics of nonneural tissues and their masterful handling. These phases are totally plastic (*Greek: capable of being molded*) in nature and therefore are most descriptively and conceptually designated as **plastic neurosurgery**. Plastic neurosurgery, like the specialty of plastic surgery, has two cardinal components: *reconstruction*, which deals with abnormal or damaged tissue, whether iatrogenic in origin or caused by disease or trauma, and *cosmesis*, which is concerned with preservation or improvement of physical appearance, i.e., aesthetics.

Surgical understanding and skills, both good and bad, have been informally passed along over millennia to trainees by observation of, interaction with, and imitation of experienced practitioners combined with gradually increasing independent responsibility. Today, all three phases of neurosurgery are learned from mentors, attending neurosurgeons, fellows, and more senior trainees. The understanding of what constitutes expert neurosurgery or just acceptable practice is not uniform, and technical expertise among mentors varies with respect to attention to detail and knowledge of the physiology of healing. The details of the opening and closing of doors for phase two neurosurgery are too often learned by rote (defined by

Merriam-Webster as "mechanical or unthinking routine or repetition" and by Collins English Dictionary as "learning things by repeating them without thinking about them or trying to understand them). This is not necessarily the best way to teach or learn. Neurosurgeons learn in the formative years of their residencies and fellowships the *what* and *how* of plastic neurosurgery. It is important that they also learn the *why*.

The many details of plastic neurosurgery are strewn across decades of journals on varying subjects. However, many practical details and nuances exist only in the knowledge base of experienced expert practitioners. This latter subset of neurosurgical lore has minimal representation in the literature, perhaps because it has been thought to be too trivial or self-evident to be recorded. The absence of a dedicated source on the plastic components of neurosurgery has been an unrecognized impediment to teaching, learning, and practice of neurosurgical opening and closing skills. Plastic neurosurgery is and always will be the alpha and the omega of *all* surgeries on the nervous system.

Part I: Foundational Information for Plastic Neurosurgery

Detailed knowledge of the anatomy, healing, and handling of the tissues that encase the central nervous system is required for planning and execution of all neurosurgical approaches, restoration of tissues, treatment of neurotrauma, and management of complications. These tissues receive a paucity of attention in neurosurgical literature. It is the ability of these tissues to heal that makes neurosurgery possible and prevents complications if the tissues are handled appropriately.

The surgery of these encasing tissues, particularly skin, receives minimal focused teaching in the course of neurosurgical training. This was appropriate when neurosurgical training began after one or more years of meaningful general surgical experience, but neurosurgery residents now begin their training with only the knowledge and technical skills learned in medical school. The consequences of this difference in the initial experience can pass with little recognition, through residency and fellowship, and have career-long effects on the suboptimal techniques that can lead to infection, scarring, and patient dissatisfaction or poor outcomes. Successful completion of neurosurgical residency is not currently conducive to understanding surgical management of skin, bone, and dura.

Surgery of fascia and muscle is not commonly discussed among neurosurgeons, and focused descriptions on techniques are nearly nonexistent in neurosurgical literature; yet their surgical disruption and need for reconstruction are important components of most neurosurgical operations. Fascia overlying muscles of the temporal fossa, posterior fossa, and spine is commonly incised and must be repaired. The surgical management of muscle too often includes unnecessarily destructive incisions and suboptimal restoration. Chapters Part I address skin management and include discussion of dressings, bandaging, postsurgical management of neurosurgical wounds, and discussions of fascia and muscle.

The gross surgery of cranial bone and dura is often mentioned in neurosurgical literature, but the finer points of hemostasis and optimization of healing receive much less attention. Complications related to bone include suboptimal intracranial exposure, imprecise alignment of fragments, nonunions, cranial defects, infections, and cosmetic defects. The first of these, although well known, is not often categorized as a complication, unless severe. Dura mater has an important role in the growth and healing of cranial bone and in providing a constraining envelope for the central nervous system and cerebrospinal fluid (CSF), particularly in children. The surgical management of dura is important in optimizing surgical exposure and preventing CSF leakage, infection, and pulsatile cranial defects. Techniques for the management of disruptions of cranial bone and dura are reviewed.

Part II: Opening and Closing Neurosurgical Doors

The opening and closing of neurosurgical doors—phases one and three of plastic neurosurgery—are described for a variety of representative neurosurgical approaches. These are presented in three groups: intracranial, spinal, and peripheral nerve surgery. The optimization of surgical exposures and the reconstruction of bone and soft tissues are described with appropriate citations. Minimal attention is given in this book to surgery on neural tissues—i.e., phase two of neurosurgery. The plastic neurosurgical components of neurosurgery vary greatly in complexity from simple (e.g., making a twist drill hole for inserting a pressure monitor) to complex (e.g., the transfrontal-subcranial approach for removal of a tumor).

Detailed descriptions for intracranial approaches to supratentorial, posterior fossa, and subfrontal sites are described. The ideas expressed reflect the individual authors' experiences combined with information gleaned from written neurosurgical, plastic surgical, and other sources, in addition to opinions of plastic surgical colleagues and various trainees. Plastic neurosurgical approaches for spinal surgery are detailed; however, surgery on vertebrae, being another major but separate subspecialty of both neurosurgery and orthopedic surgery, is not included. Plastic neurosurgical approaches for the exposure of the peripheral nerves are described and illustrated.

Many if not most avoidable neurosurgical complications, including hematomas, CSF leakage, surgical site infections, dehiscences, and problematic bone flaps, have their roots in problems with the opening or closing of neurosurgical doors. Less often recognized as complications are intraoperative struggles caused by suboptimal exposures, which increase the risk of complications in the second phase of surgery. However, not all neurosurgical complications/adverse outcomes are avoidable. It is important to distinguish the avoidable from the unavoidable and not self-criticize or ascribe guilt for the unavoidable. That said, it is notable that too often complications are often conveniently interpreted as unavoidable.

Belief that cosmesis is of little importance, except on areas of skin that are visible in a mirror or apparent to others—e.g., face, neck, and arms—is erroneous. Patients, spouses, and parents of children universally dislike scars, and not just the

unsightly ones. All surfaces of the body are important to patients. Lay persons commonly associate the appearance of surgical wounds with the perceived attention given to tissues beneath the skin. Neurosurgeons also notice and privately opine on the appearance of surgical wounds. Avoidable cosmetic deformities are complications; however, unless severe, they are very often understood to be unavoidable collateral damage and are almost never mentioned in M&M conferences, tabulations of complications, or neurosurgical writings. Nevertheless, cosmesis is of great importance to patients and should be to their surgeons.

Part III: Plastic Neurosurgery for Cranial and Craniofacial Disorders

Surgeries for corrections of nonsyndromic craniosynostoses and other disorders of the cranial vault are major components of pediatric neurosurgery and, depending on the neurosurgeon's experience, may be done with a craniofacial surgeon. These surgeries consist almost totally of an opening, remodeling of bone, and reconstruction with attention to cosmesis—i.e., phases one and three of plastic neurosurgery. Neurosurgeons often participate in the planning and execution of surgeries, particularly of the osseous and dural components, for correction of syndromic craniofacial disorders. It is essential for neurosurgeons who are involved in the management of all cranial and craniofacial disorders to have a broad understanding of these disorders and *never* accept the role of technician for only making designated burr holes and osteotomies.

Unlike most indications for surgery, decision-making regarding patients with craniofacial disorders is strongly influenced by aesthetic concerns and can be a focal point for plastic surgeons. Still, the management may require relief of intracranial hypertension by neurosurgeons. Although there can be no definitively correct aesthetic opinion, surgeons are the authoritative sources on risk and realistic expectation. Intuition and experience with non-craniofacial disorders are not sufficient for these patients and can lead to avoidable complications. Many techniques developed for craniofacial disorders have applications in neurosurgical approaches to the cranial vault, thereby making familiarity with craniofacial techniques applicable for many elective cranial approaches and reconstructions following trauma in patients of all ages.

A small but significant component of pediatric neurosurgical practice consists of involvement in the treatment of rare disorders, for which there is no universally accepted surgical procedure or approach. Often, neurosurgery is near totally plastic in nature, is technically challenging, and has high risks for the child. The neurosurgeon is unlikely to be comfortable in making confident decisions on many of these cases because of lack of in-depth knowledge and experience. Most encephaloceles, for example, are repaired by pediatric neurosurgeons; however, the skills of a craniofacial surgeon may be required for lesions that are in frontal or frontonasal locations. Reduction cranioplasties and repair of some expanding fractures are challenging undertakings for the experienced neurosurgeon and have significant

risks. The extremely complex and high-risk multispecialty management of composite-type aplasia cutis congenita and the separation of craniopagi are briefly summarized for neurosurgeons who need a source of reliable information when consulted or questioned on these subjects. Familiarity with various plastic techniques is very beneficial for appropriate and successful neurosurgical treatment.

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