
Anthony J. Raimondi

Pediatric Neurosurgery

Theoretical Principles –
Art of Surgical Techniques

Updating of the Neuroimaging by G. Trasimeni
The Chapter on Epilepsy Written with F. Cardinale

Second Revised and Enlarged Edition
with 567 Figures in 1514 Separate Illustrations, 355 in Color
and 47 Tables



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To my wife, Lucia
and my son, Marco Antonio

Preface to the Second Edition

“Old men that knowen the grounde
well yenoughe
Call it the battell of Otterburn:
At the Otterburn began this spurne
Upon a monnyn day.
Ther was the daughte Doglas slean:
The Perse never went away.”
ANONYMOUS*

“Thys fraye bygan at the Otterborn
Bytwene the nyghte and the day;
Ther the Douglas lost his lyfe,
and the Percy was lede away.”
ANONYMOUS*

There are three compelling reasons for an Author to undertake a second edition of a text book: correction of unacceptable errors or inexactitudes, up-dating (putting into perspective) new concepts and techniques, the very personal wish to express more completely and graphically his messages. My goal for this Edition is – within the limits imposed by true differences of opinion – to present a corrected text reshaped by time, and enriched by an exhaustive personal reading of the literature pertaining to pediatric neurosurgery during the 10 year period 1987-1997. At a time-distance of 13 years from the date the First Edition was given to the publisher, the Second Edition left my desk for Heidelberg, holding reviews of papers heard, journals and articles read, thoughts clarified.

The methodology consisted of stacking clinical notes and publications according to themes, highlighting messages to discuss or convey, writing these then as critical reviews, and lastly re-reading the text of *Pediatric Neurosurgery: Theory and Art of Surgical Techniques* with Dictaphone in hand to re-elaborate the new text. Hence, some sections of this work are verbatim reprintings from the First Edition, others are new, and others still are re-evaluations of the subject or the context of their expression. The narrative style chosen remains that of writing in the first person (so as to avoid the implication that the information given is the eternal truth), with concepts and conclusions developed consequentially. Thus, surgical attitudes and/or principles along with clinical theory are structured upon anatomy, pathology, clinical problems, operative methodology, interpretation of results... and developed as considerations, perspectives, approaches.

To simplify, enrich, communicate visually the narrative message, extensive use is made of MRI, line and half-tone and color drawings, tables. Every effort was spent to bring these into spatial proximity to the texts, though at times we did not succeed. Color was chosen when it was necessary to distinguish clearly between adjacent anatomical structures, half-tones for perspective, line drawings for focus or concept. The tables used are either new elaborations, transcriptions from other writings, or re-workings of the two, and the design for their use is didactic and documentary.

As for the First Edition, this text has all the advantages and disadvantages of a single-author treatise, though I have painstakingly – throughout the literature review and multiple re-readings over time – attempted to incorporate other perspectives into the work. Nevertheless, one sees with his own eyes, thinks with his own mind. There is an absolute and pervading difference between an Editor and an Author. Thus, the

*RELICS OF ANCIENT ENGLISH POETRY. Two ballads sung by two *different* anonymous minstrels, relating a “historic” single event which occurred within the living memory of the listeners... with two very different issues.

aseptic and telegraphic, at times disjointed, conglomerates of information and attitudes of a multi-authored book are counterbalanced against the defined visual arc of a single author. As an information source for those who wish to practice the theory and art of pediatric neurosurgery, I think a single author treatise is preferable.

Let us see now what this book holds, and let us outline its methodology and goals:

The imaging studies, by and large, were selected and collated by Dr. Guido Trasiemi, at the University of Rome (La Sapienza), who also interpreted the observations. This is the natural course of events now that the neurosurgeon is no longer... also a neuro-radiologist. I think this has strengthened considerably the overall value of the text.

The list of contents – introduced by its *specific philosophical message, as all chapters of the book* – has been extensively re-worked by the copy-editor to provide as detailed a flowing sequence of the order of presentation as possible. A careful reading of this presentation before undertaking a systematic study of the treatise or only consulting it in search of an answer to a particular question is recommended. It expresses telegraphically the structural development of the narrative content.

Positioning introduces immediately the reader to all three of the reasons cited in the first paragraph of this Preface for writing a Second Edition: correcting errors or inexactitudes, updating the text, a more complete and graphic expression of my message. It integrates imaging studies into the exercise of conceptualizing the target area and sets them as closely as a two-dimensional image may be placed to a three-dimensional representation: the reader looks at the image as though he were the surgeon. The glaring error of rotating the semi-seated child around the axis of the table-top is corrected, with illustrations showing how this brings the child into a complete vertical position. The answer to the position problem is presented.

The same illustration techniques are used in **Incisions**, integrating even more completely the images into the half-tone drawings, adding new color drawings for skull-base procedures. **Hemostasis** was integrated with the **Incisions** chapter to eliminate repetitive and confusing descriptions, since with an incision one begins hemostasis. **Flaps, Suturotomy, and Dural Openings** remain unchanged in content: no perspectives for performing these have been developed, and access to the base of the child's skull is fully achieved without resorting to the osteoclastic techniques recommended by some for surgery on adults. In **Cerebral Retraction**, anatomical drawings of normal structures are added to give depth to the descriptions, a section of the surgical technique for preserving the anatomical integrity of the olfactory nerves is added. **Cerebrotomy** and **Cerebral Resection** are unchanged.

Epilepsy is a new chapter, added because of the great interest in the surgical treatment of this affliction during the past 10 years. It was written with Dr. Francesco Cardinale, who put together all of the material. Since this treatise is on pediatric neurosurgery, this chapter is written informatively: it is not a treatment of epilepsy as a clinical and surgically amenable disease state. This must be dealt with by epileptologists, who write for those who understand the principles and are qualified to apply the surgical techniques. Pediatric neurosurgeons, with rare exceptions, limit themselves to referring children to highly specialized centers. Hence, this chapter is an in-detail, but very elementary, reference source. It provides all the information a generalist needs, and stresses the indications for referring the children to surgical epileptologists.

In **Tumors**, one finds a very extensively re-written and expanded text. Clinical information, such as incidence and percentages of individual tumor types, documentation of incidence of complicating hydrocephalus along with the results of treating it pre-craniotomy. Tabular summaries of tumor resection results and survival rates compose a significant portion of the Introduction. This was done to provide a base upon which the clinical considerations could be built. Then, at the very beginning, skull base and bony tumors are dealt with in the new style of integrating imaging studies into the clinical and operative planning methods... as already commented upon for the earlier chapters and as is continued throughout the subsequent ones.

Weaving epidemiologic and clinical data into surgical considerations and technique set a lively reading pace which I hope will permit the reader to dwell upon each tumor type, confronting one with the idea of evaluations concerning treatment options. It is here that I have tried most to establish a personal contact with the reader, to welcome him to an open and spontaneous “discussion” with this book. The full breath of pediatric brain (eye included) and mesenchymal tumors unfolds from external (chordoma) to internal (choroid plexus papilloma), as the extensive literature review and re-evaluation of my personal cases are brought into the original text, as standard middle and posterior fossa approaches are revisited and developed into the more modern “skull base” terminology and perspectives. The critical review component is present throughout, most affirmatively in medulloblastoma, craniopharyngioma, ependymoma, intramedullary tumor.

In **Vascular Disorders** the continuing value of cerebral angiography, the role of MRI, and dramatic shift to intravascular approaches to such complex problems as arterio-venous malformations of the galenic system are broadly treated. Advances in anatomic and embryologic knowledge form the basis for new treatment methodologies, which are not within the surgical armamentarium of the neurosurgeon. The confrontation of surgical and intravascular approaches seems close at hand, for microsurgery (especially of the “keyhole” variety) brings us to a strong enough position to reconsider freshly the issues at hand. **Infections** opens with a thorough review of all – primary and secondary – surgically related infections, and then proceeds to discuss surgically treatable diseases, and **Trauma** is expanded considerably to bring newer concepts in coma classification and socio-economic causes of the “battered child” syndrome into our areas of knowledge. Post-traumatic vascular pathology is considered here rather than in **Vascular Disorders**.

Congenital Anomalies and **Hydrocephalus** are extensive re-workings, incorporating the most recent theoretic and technical consensus ranging from craniosynostoses through the lipoma and into a totally new perspective of hydrocephalus (its pathogenesis primarily, but also classification). The Chiari malformations, syringomyelia, arachnoidal cysts are integrated into a readily comprehensible group of anatomic-pathological clinical entities which appear to be inter-related.

As in the First Edition, I made all of the drawings in the conceptive stage. These sketches were then presented to Ruth Daly (for the First Edition) and Marina Longani (for this, the Second Edition). Each of these two extraordinarily gifted young ladies then patiently and skillfully worked the sketches into the finished products this book holds.

It is my hope that the owner of this book will read it, at first as though it were a novel, and then refer to it as he would to a friend, a colleague, a teacher – but always conclude by “trusting his own crooked eye”.

Acknowledgements

Five people – four already mentioned – contributed significantly to this book, to the extent that their names need special emphasis. The four already mentioned are Ruth Daly, Marina Longani, Guido Trasimeni, Francesco Cardinale. The unmentioned one, Lucia Duran Raimondi, my wife, scanned the literature, collated the bibliography, typed the manuscript repeatedly, integrated the illustrations into the text, and picked up all the pieces I dropped... re-inserting them quietly and efficiently into their proper places.

Preface to the First Edition

*“Better is a dinner with herbs where love is,
than a stalled ox and hatred therewith.”*

SOLOMON, Kings – The Holy Bible

Lest the preface become an essay, lest it stand alone and independent of the text, I shall limit it to presenting the What, the Why, and the How of this work.

The What is the subject of the Introduction. There, the reader will find a narrative integrating selected fundamentals of this book’s contents into specific perspectives of what Pediatric Neurosurgery is as a theoretic and a technical discipline.

The Why results from the development of our field as a speciality and, as such, is beyond communicating its many messages only through articles, conferences, chapters, and sections of “Handbooks.” Pediatric Neurosurgical centers have been established, providing much clinical experience and varying amounts of experimental opportunities to integrated groups of workers, carrying on their activities, more or less, in a collegial manner. Though not recognized as an independent speciality by international, regional, or national adult neurosurgical organizations, Pediatric Neurosurgery is *de facto* recognized by pediatricians, by *all* other medical and surgical specialities, and by Society. It is taught at the undergraduate level in medical schools, and at the graduate level in such specialities as neurosurgery, neuroradiology, neurology, pediatrics, and anesthesiology. Its principles are being established, its limits extended and defined, and its practitioners indentified. Texts are needed.

By and large, multiauthored books dealing with an entire field are disjointed, eclectic works, allocating limited pages to almost unlimited numbers of subjects, each dealt with by different clinicians. A common thread is wanting; the woof and the warp often fail to strengthen one another or to form a pattern. Bibliographic and clinical reviews abound.

I chose to undertake this work alone, attempting always to remember Donald Matson’s words when I asked his advice concerning what I should include in my book Pediatric Neurosurgery: “Tony, write only what you know and express it as you see it.” Therefore, the reader will find some subjects and chapters that are strong, some that are weak, some that satisfy him and some that don’t. He will encounter throughout the text a direct and consequential relationship between diagnosis and surgical indications, between recommending surgery and knowing what result (quality of life) one may reasonably expect, between surgical technique and attaining the desired therapeutic goal.

The How of a book such as this (how it is conceived, composed, constituted, and completed) determines its effectiveness. The author’s contribution to the subject, in turn, is a mosaic of mentality and motivation, experience and readings, analysis and synthesis. All of these are inspired by a composition of oneself, his teachers, his students, and his patients. By the time a physician enters the third phase of life, his learnings and the absorbable messages of his teachers have blended into a single cog-

nition. His emotions and volitions are the stuff that permit him to make the transition from student to teacher.

Perceptive and constructive students contribute by their very presence: by learning quickly and well, they first reward and then stimulate the teacher to move on, to identify new problems and to solve them, to formulate new clinical perspectives, and to give substance to new surgical techniques. I have been blessed with many such students who, by virtue of intelligence, diligence, and total dedication also supplemented one another's education . . . and training. Their very different national origins and ultimate goals in life formed the basis for a truly humanistic school of Pediatric Neurosurgery: we always were foresquare in front of the reality that sick children are sick children everywhere in the world, that their parents suffer equally irrespective of the gravity of the illness, and that their needs for neurosurgical care *must* transcend the economic or academic needs of the physician. The bittersweet: from time to time I am discomfited by the truth of Saadi's recollections . . . "Never have I taught a student archery without, in the end, becoming his target" (Saadi, *The Rose Garden*, circa 1280 A.D.).

Still, when everything is said and done, how does a book that hopes to be a humanistic treatment of a scientific discipline, one composed of theoretic and technical elements, come into existence? I have no answer to this question. I do have a need to express, in a very few words, the humanistic part of my being, as a Preface to what the reader will find as he encounters the scientific aspects put forth in words, illustrations, and photographs. In holding myself out to treat diseases or injuries of a developing, and growing, brain, and to teach these perspectives and arts to others, I have never ceased, not for a moment, to be overwhelmed by this awesome responsibility, this unique privilege – both having resulted in polarizing my conscious efforts to my life's work. These latter came from my love for my own children. My vow to dedicate myself to Pediatric Neurosurgery was made when I spent two months with my newborn son Marco on 2-East at Children's Memorial Hospital. Marco, Laura, and Paolo (my children) remain the most human, powerful, forces I have ever felt; they have given me the perspective to see my parents, Vito Orazio and Leona, and the understanding that a child and his parents are one: neither dominates, neither may decide for the other without deciding for himself. Pediatric Neurosurgery, sociologically, is Family Neurosurgery, and I have found that it cannot be practiced with equanimity without becoming a member of the Family.

Acknowledgements

I wish to express my gratitude and recognition to Lucia Duran, Ruth Daly, Elizabeth Sachs, Deborah Crocket, Barbara Stevens, Barbara Ann Quintero, and Jack Leb for their full measure of participation in various aspects of the preparation of this work. Theirs was not just a duty discharged, it was in every way an expression of understanding, support: a sincere application of individual and personal perception and skills to an undertaking which required today's sacrifices for tomorrow's results. I hope they will be satisfied.

Koreaki Mori prepared the section on shunt characteristics and external ventricular drainage, Luis Yarzagaray the ventriculo-gallbladder shunt, and J. Thomas Brown the intrauterine shunt. Yutaka Maki made me aware of Monk Kukai (priest who contemplated sea and sky).

The staffs at Springer-Verlag and Stürtz were truly professional and human, understanding my desires, concepts, and apprehensions.

The last impression I wish to leave the readers, who are careful enough to peruse this section, is that an author cannot complete a book such as this unless he has been motivated continuously throughout its conception, writing, editing. In my case, that motivation is the result of a desire to pass on to the medical world the benefits I received from my patients, their families. I thank them for their trust and their confidence.

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*All too often we get so lost in our work on Earth
that we forget life is a transition between sea and sky.*

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1 Positioning

“If you have planted a thistle, do not expect jasmine to sprout –.”

SAADI, The Fruit Garden

It is not realistic to specify the single most important aspect of an operative procedure, namely, diagnosis, anatomical localization, blood volume control, flap selection, exposure, or head and body position. It is realistic, however, to assert that, if the surgeon positions the child’s head and body properly – taking into consideration the location of the lesion, the planned skin incision, and bone flap – he will, throughout the operation, be oriented anatomically – he will always have the lesion at the center of his operative field.

One of the most significant equipment/instrument advances hitherto made for neurosurgery, neuronavigation, is still of no value in operating on newborns and infants, and of very limited value in operating on toddlers. There are two principal reasons for this conclusion: the thin skull does not lend itself to the use of rigid frames, and the commonly present secondary or primary hydrocephalus predisposes the brain to major shifts within the cranium once the dura is opened.

On the other hand, the wide range of applicability of endoscopic procedures finds many indications in the pediatric ages. Neither of these methodologies, however, simplifies the matter of positioning the child. In fact, as we move forward with minimally invasive surgery, we find it ever more important to obtain precise positioning.

Positioning for pediatric neurosurgery varies considerably with the age of the child (newborn, infant, toddler, juvenile), the number of surgeons (one surgeon alone, surgeon and assistant, etc.), the location of the anesthesiologist and amount of monitoring equipment used, and the target area.

These variables are generally not applicable to neurosurgical operative procedures on adolescents and adults because of their uniform size, and the constant relationship between brain and skull. Also, there is no need for such anatomical considerations as open fontanelles and sutures, relatively larger basal cisterns, continuity of the

periosteum with the outer layer of the dura at the sutures, and the presence of ossification centers. Therefore, this chapter is organized to present general and specific considerations concerning each age group, individual body positions, relative position of surgeon vis-à-vis the child, and positioning of the head. The recommended positions for specific operative procedures are then discussed before they are described.

General Discussion

Age

The relative sizes of the surgeon’s hands and the head of the newborn, infant, toddler, and adolescent place into relief the remarkable differences in dimension of skull and brain in the different pediatric age groups. This range in overall head size is expressive of a proportionate range in individual anatomical structures (lobes of the brain) or compartments (basal cisterns), since they vary individually, and disproportionately, from the newborn to the toddler.

The head of a premature newborn may be so small as to fit within the palm of the surgeon’s hand (Fig. 1.1A), whereas that of a term newborn rests comfortably within the fully cupped adult hand (Fig. 1.1B). The heads of the infant and toddler (Fig. 1.1C,D) are proportionately larger (the same hands are used in all four photographs). This change in volume occurs *pari passu* with changes in dermal (skin, connective tissue, and aponeurosis of the scalp) thickness, inversion of relative amounts of diploic and lamellar components of the skull, diminution in volume of cisternal cerebrospinal fluid and increase in cerebral volume, and closure of fontanelles and narrowing of the sutures. In all four of these age categories the air sinuses are not yet developed, and the second dentition tooth buds occupy the