Paolo Cappabianca
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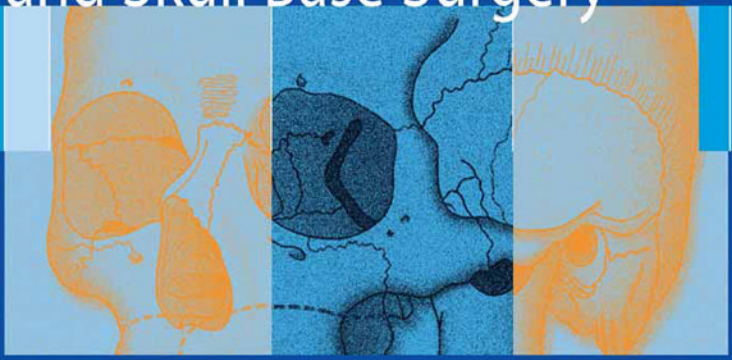
Editors

Cranial, Craniofacial and Skull Base Surgery



Foreword by
Michael L. J. Apuzzo

Springer

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Foreword

The Fruits of Reinvention

Surgery related to the human head, its compartment and contents has been reinvented over the past 40 years. A number of instruments, most notably the sophisticated medical imaging device and the operating microscope, have principally fueled this evolution. Along the way, endoscopy and sophisticated navigation capabilities have added to the realization of a unique comprehension of normal and abnormal microanatomy permitting corridors and manipulations that allow novel strategies for surgery in these highly vital functional areas.

Cappabianca, Califano and Iaconetta have created a detailed and fully modern review of methods and strategies related to complex surgery and therapies associated with this robust reinvention. Technical innovations abound!

Distinguished practitioners of these unique developments in the history of surgical enterprise present these amazing technical exercises. The catalog of these approaches, instrumentation, techniques, strategies and manipulations is inspiring and stands as a testimony to the remarkable progress that we have witnessed in recent decades.

The presentation in truly "modern" and represents in many aspects pinnacles of operative achievement.

We must ask ourselves, what will be next?

Los Angeles, November 2009 *Michael L.J. Apuzzo, M.D., Ph.D (hon)*

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Preface

We belong to a lucky and happy generation, living during a period of many dramatic, if not revolutionary, technical and technological innovations, such as the digital era, which have changed and improved our routine surgical practice, together with the quality and quantity of life of our patients.

Furthermore, the possibility of easily obtaining and exchanging information has facilitated cooperation among different specialties, thus favoring a real team-work attitude. No-man's land has become an area where many subjects have settled and produced new results.

Technologies and instruments previously used by a single group of specialists have been adopted and modified by others to perform the same kind of action in a different environment. Cross fertilizations have pushed the envelope towards the management and control of diseases that could not have been imagined a few years ago.

Previous paradigms have been demolished by conceptual and technical progress that has been determined by the exchange of knowledge. For patients, functional and even esthetic and/or cosmetic demands have taken over from the naked result of saving life by hazardous surgery.

Some surgeons have achieved innovations by novel approaches and others, at the same time, have refined established procedures taking advantage of recent technical advances. An example of both these conditions can be considered the recent advent of endoscopic endonasal skull-base surgery, introduced as an approach to the pituitary region, such that some tumors and/or pathological entities, once considered amenable only to open transcranial surgery, can now also be managed through this alternative option. Another example is the standardization and diffusion of operations to the cerebellopontine angle that are performed today with fixed coordinates and indications under adequate intraoperative neurophysiological and radiological monitoring.

Further progress can be expected to result from the ongoing experience of leading centers and contemporary teaching with modern facilities. At the same time, instrument development, perhaps robotics, will add a new impulse to the never-ending effort towards achieving perfect results.

The multiplicity of possible approaches and their refinement have led us to consider this an opportune time to collect presentations from different schools on various cranial, craniofacial, skull-base extended and small-size approaches. We asked individual specialists to produce a chapter on a single technique by providing anatomical images, that we have always considered the foundation of any surgical procedure, followed by operative images and explanatory text for each operation.

We hope readers, most importantly including young surgeons, will find our efforts useful in improving their expertise in and knowledge of the various techniques described.

Naples, November 2009

Paolo Cappabianca
Luigi Califano
Giorgio Iaconetta

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Section I

Cranial Neurosurgery

Introduction

Evolution of Techniques to Approach the Base of the Skull

Francesco Tomasello

History: The Past

The skull base is not only the dividing wall between the intracranial content and the facial compartment with the upper respiratory and digestive tracts, but it also allows the passage of vital neurovascular structures entering and exiting the brain. For this reason skull-base surgery is one of the most challenging areas of surgery.

Since the first successful attempts to remove a skull-base tumor at the end of the eighteenth century, surgeons coming from different disciplines have compared their skills in this area. Skull-base surgery was the first successful brain surgery procedure. Francesco Durante, a general surgeon born in Letojanni, Sicily, but working in Rome, removed an anterior cranial fossa meningioma using an original transpalatine approach. The patient was still alive and in good health 12 years after surgery [1]. It should be underlined that this pioneer of neurosurgery used a transoral, transpalatine approach presaging the multidisciplinary approach needed in modern skull-base surgery to fully manage complex skull-base lesions.

Another pioneer of surgery worthy of mention is Sir William Macewen who successfully removed a brain tumor over the right eye in a 14-year-old boy using general anesthesia with endotracheal intubation instead of tracheostomy [2]. In the last century, advances in skull-base surgery paralleled those of neurosurgery, and ENT, maxillofacial and plastic surgery. In 1907 Schloffer was the first to report successful removal of a pituitary tumor via a transnasal, transsphenoidal approach. His approach used a transfacial route with significant esthetic problems due to paranasal scarring [2]. Three years later Hirsch, an otorhinolayngologist, first described the endonasal transseptal approach to reach the sellar content with local anesthesia [3]. Subsequently Cushing modified this approach with a sublabial incision using general anesthesia. His results in 231 patients, operated upon between 1910 and 1925, showed a 5.6% mortality rate; however, he later abandoned this technique in favor of a transcranial route due to the high risk of CSF rhinorrhea, difficult in controlling hemorrhage and postoperative cerebral edema [2]. Dott, learning the transsphenoidal approach directly from Cushing, reported in 1956 no deaths in 80 consecutive patients.

The next milestones in the evolution of transnasal-transsphenoidal technique were reached with the routine use of two different technical adjuncts. Guiot, introducing the intraoperative radiofluoroscope, extended the approach to craniopharyngiomas, chordomas and parasellar lesions and, finally, Hardy from Montreal, Canada, proposed and diffused the use of the surgical microscope and dedicated instrumentation [4]. Thus, the evolution of the transphenoidal approach to the pituitary gland and its worldwide application involved three basic factors: first and most important, the pioneering efforts of giants of surgery working on their intuition and often against colleagues' skepticism; second, the progress of technology; and third, its application to routine procedures. This is the paradigm of the skull-base surgery. In the 1960s, House, an ENT surgeon, and Doyle, a neurosurgeon, began to remove acoustic neuromas through a middle fossa approach. This was one of the first skull-base teams to introduce the concept of a multidisciplinary approach [5].

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P. Cappabianca et al. (eds.), *Cranial, Craniofacial and Skull Base Surgery*.

The history of skull-base surgery with its basic principles has to include a tribute to Gazi Yasargil. He popularized the pterional approach and demonstrated that with removal of the sphenoid wing and meticulous microneurosurgical technique many areas of the skull base could be reached without or with minimal brain retraction. Yasargil's lesson was applied to many approaches, and even today it represents the undisputed basic concept for any neurosurgeon dealing with skull-base lesions [6, 7]. The concept of "move the bone away and leave the brain alone" is the basis of modern skull-base surgery.

As in many fields of medicine, the widespread diffusion of knowledge, techniques and technologies drives surgeons through over-indication. It should not be considered as an absolute mistake, but as an unavoidable step in the continuous progress of science. This was the case in cavernous sinus surgery. In the 1980s and 1990s many neurosurgeons demonstrated the surgical anatomy of the cavernous sinus and many approaches to reach lesions within it. It seemed that the cavernous sinus, formerly considered a "no-man's land", became as accessible as any other part of the skull base and each lesion growing into or extending to it could be completely resected without significant morbidity [8–10]. However, during the last decade, the long-term evaluation of surgical results and the development of alternative techniques to manage lesions in this area generally reduced the enthusiasm of the proponents of the approach, limiting indications to the routine opening and exploration of the cavernous sinus [11, 12] (Fig. 1).

Chronicles: The Present

As with any innovation in the field of medicine, strategies for resection in skull-base surgery are first greeted with skepticism, then they diffuse with an enthusiastic underestimation of morbidity and mortality, to reach maturity with a better application to each specific case. It is hard to say if we are in the mature phase of skull-base surgery. Recent studies have demonstrated the

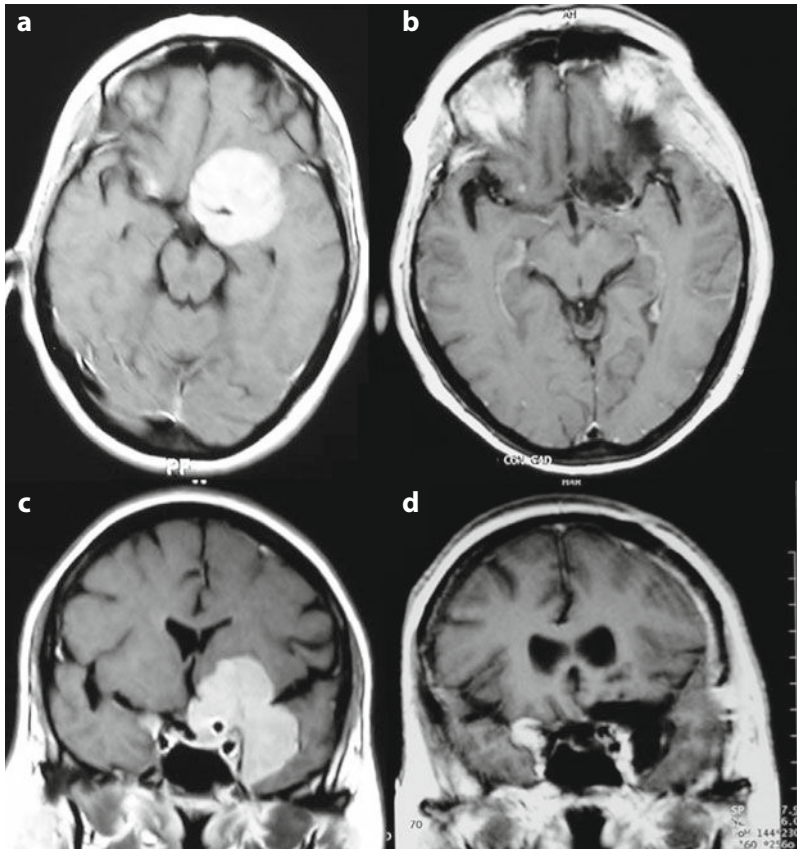

Fig. 1 T1-weighted MR imaging after contrast agent administration of a giant left sphenocavernous meningioma with a small contralateral clinoidal meningioma. **a**, **c** Preoperative axial and coronal images. **b**, **d** Postoperative axial and coronal images. The meningioma was completely resected except for the intracavernous portion via a left pterional craniotomy. Residual tumor within the cavernous sinus and the contralateral clinoidal meningioma did not show progression at the 3-year follow-up

prominent role of standard neurosurgical approaches, as the pterional or retrosigmoid, in the management of most skull-base lesions minimizing the need for a transfacial and transpetrosal route [7, 12, 13].

For many years neurosurgeons and neurotologists have discussed the best way to approach and resect acoustic neuromas. The introduction and widespread diffusion of MRI has allowed the diagnosis of small intracanalicular tumors, shifting the paradigm of management from simple tumor resection to facial nerve sparing and, finally, hearing preservation. Moreover, surgery is not the only treatment modality available to patients. Long-term results of radiosurgical series as primary treatment in these patients are now available: tumor control and preservation of the function of the cranial nerves are considered today at least comparable [14]. The discussion is still open, and no-one has the definitive answer. Modern radiosurgical techniques continue to gain a prominent role as primary treatment in many skull-base lesions and the apparently short-term morbidity should be measured in relation to long-term outcome, and both should be measured in terms of tumor control and new neurological deficits.

As outcome measures have increasingly become more sophisticated, surgeons analyzing their series cannot state that a patient had a good outcome just because no new neurological deficits occurred. Measures of quality of life as perceived by the patient and his relatives should be considered as the gold standard parameter to evaluate a treatment modality.

Neuronavigation is now a standard tool in a modern neurosurgical operating room. Its routine use in skull-base surgery can optimize the intraoperative time and make the surgeon confident in the identification of major skull-base vessels during bone dissection. How it modifies the outcome is matter of controversy. Technological advances have almost always anticipated major improvements in skull-base surgery. This was the case for endoscopy and its introduction into skull-base surgery. Neurosurgeons capitalized on the ENT surgeons' experience in endoscopic surgery of the paranasal sinuses [15]. Jho, Cappabianca, de Divitiis and Kassam were pioneers in this field [2, 16]. Jho and Carrau (the latter an ENT surgeon) reported the first surgical series of 50 patients harboring a sellar lesion operated on via an endoscopic endonasal approach [17]. In the last 10 years under the guidance of Naples and Pittsburgh centers, hundreds of endoscopic procedures in the sellar region have been performed all over the world. The use of a pure or assisted endoscopic technique to approach the sellar region is probably the most important conquest in contemporary skull-base surgery.

Vision of the Next Step: The Future

Recently the Naples and Pittsburgh groups have developed an extended endoscopic approach to anterior cranial fossa lesions such as tuberculum sellae and olfactory groove meningiomas. Criticism and limitations of the standard surgical technique obviously appeared greater in relation to the extended approach, in which untoward hemorrhage and CSF leakage are difficult to control [18–30]. If the endoscopic endonasal approach to the pituitary has to be considered a standard approach, its extension has to be validated in larger series.

Research and efforts should be directed toward the improvement of waterproof closure of the basal dura and the development of new instrumentation for dissection, better visualization, control of neurovascular structures and hemostasis. The use of intraoperative imaging and sonography, the development of a new dural substitute and sealants may improve the use of the endoscopic approach and make it accepted worldwide as the new frontier in skull-base surgery. Diffusion and acceptance of new outcome quality-of-life patient-oriented scales should better define the concept of minimally invasive surgery and its ability to obtain long-term tumor control.

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