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HISTORY OF SKULL BASE SURGERY

Skull base surgery is the interdisciplinary approach to lesions afflicting those areas of the deep facial structures that abut the undersurface of the cranium. This is a region that in order to achieve the optimum result requires the expertise of at least two surgical disciplines, usually the head and neck surgeon or neuro-otologist and neurologic surgeon. The plastic and reconstructive surgeon is often needed for reconstruction once the surgical extirpation is completed. This is especially true when a free flap is required. The importance of the neuroradiologist and the interventional arteriographer in the preoperative diagnosis of tumor extent and the studies of vascular integrity and cerebral blood flow cannot be overemphasized. The roles of the neuro-ophthalmologist, nurse clinician, anesthetist, and pathologist are important as well. The most effective therapeutic scenario is when the members of these disciplines are all integrated into a "skull base team."

This concept of an interdisciplinary program where the skills and expertise of a number of health professionals are brought to bear on a difficult set of disease processes of extreme complexity is a relatively unique idea in modern medicine. In a milieu where turf battles between physicians, conflicts with insurance carriers and the government, problems concerning medical malpractice, and difficulties related to hospital politics and finances abound, this concept arises as a refreshing change. The thrust is a patient-oriented emphasis with an attack on a complex disease process rather than being a doctor, hospital, or fiscally oriented focus.

HISTORY

The advances experienced in modern otolaryngology-head and neck surgery, neurosurgery, and plastic surgery have been little short of amazing. However, until relatively recently, tumor unresectability had been established at artificial boundaries in essence created by the lack of understanding of the anatomy and physiology of the areas of interface between traditional head and neck surgery and neurologic surgery. Moreover, the concern regarding the potential problem of reconstructing the resected area limited the aggressiveness of the ablative surgeon.

In the preantibiotic era, pioneering neurosurgeons such as Schloffer,[1] Cushing,[2] and Hirsch[3] were the first to enter the cranial vault through the structures of the face. This was in the form of the transnasal approach to the pituitary fossa. The mortality rate was only 5%, and mostly due to meningitis. This was the preferred route for Cushing and his colleagues for the next 10 to 20 years, at which time they elected the transcranial approach, presumably due to the problem of infection. Osker Hirsch, however, continued to use the transnasal route and in 1952[4] reported on 425 such procedures that he had done.

The history of modern craniofacial surgery began in 1941, when Dandy,[5] while removing an orbital tumor with an approach through the anterior cranial fossa, extended his resection through the ethmoids. Rae and McLean[6] in 1943 reported a combined transorbital, transcranial excision of a retinoblastoma. However, the landmark article in skull base surgery was in 1954, when Klopp teamed up with Smith and Williams[7] to do what is recorded as probably the first craniofacial resection in that area done through separate transcranial and transfacial incisions. The tumor was described as a cancer of the frontal sinuses. It is ironic to note that it was said that this technique gained little acceptance at the time; an experience familiar to many of us in our early attempts to do skull base surgery for tumors. Malecki[8] in 1959 reported a craniofacial resection for ethmoid carcinoma and described a resection of the cribriform plate. However, it wasn't until 1963 that Ketcham and colleagues[9] reported on the first group of patients that had undergone skull base surgery for malignancy. They described 19 patients with malignant tumors, mostly originating in the paranasal sinuses, who had undergone anterior craniofacial resections. Ketcham et al.[10] followed this up with an article on complications and finally a report in 1974[11] of a 14-year experience with 48 patients who had a 53% determinate 5-year survival rate.

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The development of the binocular operating microscope by Holmgren in 1922 revolutionized the surgical treatment of deafness.[12] In 1961, Dr. William House[13] pioneered the subspecialty of neuro-otology by removing an acoustic neuroma for the first time through the middle fossa approach. He joined with a neurosurgeon, John B. Doyle, M.D., to form one of the first skull base teams. In the years since, the subspecialty of neuro-otology has flourished with the development of many new and innovative procedures. However, for more extensive tumors, the cooperative efforts of the neurologic surgeon became obviously indispensable.

The next major breakthrough was by Dr. Ugo Fisch[14] when he described in 1977 his approach to glomus jugulare tumors through the infratemporal fossa. In the same year, Gardner and colleagues[15] described their unique approach to glomus tumors through the transcervicomastoid approach. Schramm[16] and Sekhar,[17] using an adaptation of Fisch's infratemporal approach, developed an attack on benign and malignant tumors of this region. Using a craniotomy flap that includes part of the middle fossa floor produced excellent access to the petrous carotid, cavernous sinus, and nasopharynx. Further work by Sekhar and colleagues,[18] Parkinson,[19] Dolenc,[20] and Al-Mefty and Smith[21] has revealed the intimate anatomy of the cavernous sinus as well as providing a number of safe approaches to resections of tumors contained therein. This frightening area was always considered surgically inviolable until these surgeons showed us that surgery was not only possible, but safe and effective.

With the development of microvascular surgery in 1960 by Jacobsen and Suarez[22] and then Nakagama and colleagues,[23] the transplantation of free flaps was born. This has become an essential adjunct to the reconstruction of the extensive defects left by cranial base exenteration. Although free grafts and regional flaps are important elements in the resurfacing and reconstruction of these areas, often a free flap will give the only real insurance of a clear separation of the intracranial cavity and the upper aerodigestive tract.

Although the surgical management of these cases is the central focus, a revolution in the accuracy of preoperative evaluation of precise tumor extent has been made possible by the introduction of the computed tomography scan and magnetic resonance imaging. The development of gadolinium as a tumor-enhancing agent has greatly improved this precision. Balloon occlusion arteriography, especially when combined with radioactive xenon cerebral blood flow scanning, can be used to predict the integrity of contralateral internal carotid artery blood flow to the brain. This renders much more predictable the safety of internal carotid artery sacrifice.

The nurse clinician and the skull base team clinical coordinator are invaluable members of the team. Their interactions with the patient and family in coordinating the myriad of consultations and special tests, answering the family's questions and coordinating the patient's care in the intensive care unit, on the ward, and at discharge, are essential services.

THE FUTURE

Such groups as the North American Skull Base Society, the International Skull Base Society, and the European Skull Base Society provide invaluable opportunities for the exchange of information regarding the management of these difficult patients.

In the wake of the flush of excitement and enthusiasm following the well-attended first meetings of these societies, we must be careful not to lapse into torpor or lethargy. Innumerable problems, challenges, and dilemmas face us at the present time. The search for a universally acceptable data base and for a reliable and safe way to collate carefully and to manage the data collection is a pressing need. We need to know what our results are, especially in the treatment of malignancies.

Prospective therapeutic protocols for the management of controversial lesions need immediate attention. The surgical treatment of nasopharyngeal carcinoma, the resectability of upper aerodigestive tract cancers, even benign tumors with direct invasion of the brain, and treatment of chordoma, skull base chondrosarcoma, and extracranial-intracranial meningioma are only a few.

A more accurate diagnosis of adequacy of cerebral blood flow from contralateral sources requires more refinement by neuroradiologists. Perhaps the single-photon emission computed tomography scan or its refinement may supply the answer. A means of accurate detection of direct tumor invasion into the carotid artery will be a great advance.

Refinements in reconstructive surgery to produce better function and improved cosmesis are great challenges as skull base operations become more radical and more extensive. We need more time-efficient and more effective means of reconstruction.

Difficulties in establishing what an adequate resection margin is with tumors spreading along nerves, fixed to dura, and invading brain need to be overcome. Prospective studies and the use of a universal data base should lead to the resolution of this dilemma.

The intrusion of government and third-party payers into the practice of medicine and surgery is a distressing fact of modern times. The establishment of appropriate International Classification of Diseases and Current Procedural Terminology codes for skull base diseases and the proper categorization of their treatment are serious problems that the North American Skull Base Society have been asked to solve. Our input is essential.

The future for skull base surgery appears very bright. The reality of a multidisciplinary, eclectic approach to the solution of a difficult disease process has been established. There are numerous fertile areas of study and endeavor. We must carry our enthusiasm forward and exploit this

unique opportunity to unite our collective thinking to the resolution of the many complex and vexing problems posed by tumors and disorders of the skull base.

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