Introduction

The Advent of Minimalism in Neurosurgery

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NEUROSURGICAL MINIMALISM, the concept of operating on the nervous system through the least damaging route and by the most precise instrumentation, originated early in the 20th century.

Harvey Cushing, the father of American neurosurgery, was still in training at The Johns Hopkins Clinic when the first successful transsphenoidal approach to removing a pituitary tumor was performed by Schloffer (1) in 1907. Endoscopy and minimally invasive surgery of the brain date back to 1910, when Lespinasse (2) introduced a small cystoscope into the ventricles of two hydrocephalic infants in an attempt to fulgurate the choroid plexus. In 1937, Pool (3) illuminated a simple cannula with a modified otoscope to perform myeloscopic examination of the cauda equina; direct visualization of the dorsal nerve roots allowed the differential diagnosis of herniated nucleus pulposus, hypertrophied ligamentum flavum, adhesive arachnoiditis, benign neoplasm, and metastatic carcinoma. As early as 1939, Love (4) advanced the basic principle of microdiscectomy, interlaminar removal of a protruding intervertebral disc with a small incision and without resection of bone. Stereotactic surgery — directing the tip of a needle in three planes to a predetermined locus inside the skull — was based on the pioneering work of Spiegel et al. (5) in 1947 and Leksell (6) in 1949.

Neuroradiology began in 1918, when Dandy (7) intentionally replaced ventricular fluid by air to obtain radiographs of the cerebral ventricles. The use of Lipiodol to outline the spinal subarachnoid space was devised by Sicard and Forestier (8) in 1922 as an aid in the localization of spinal cord tumors. Moniz (9), in 1934, was the first to perform carotid angiography, in an attempt to opacify the intrinsic vessels of the brain. By the end of World War II, the increasing availability of pneumoencephalograhy, myelography and cerebral arteriography made it possible to provide correlative roentgen diagnosis and localization in diseases of the nervous system. Refinement continued with stereoscopic views, magnification and subtraction technique. Noninvasive imaging was finally possible when Hounsfield (10) introduced computerized transverse axial scanning in 1973.

Minimalism in neurosurgery became centered on microsurgical technique in 1955, when Malis (11, 12) employed a binocular microscope to operate on an animal brain, along with bipolar coagulation, which provided limited cautery between the ends of a microforceps and kept the intrinsic cerebral arteries patent. Kriss and Kriss reported that Kurze, in 1957, was the first neurosurgeon to bring a microscope into the operating room to assist in removing a neurilemoma of the seventh cranial nerve (13). The concepts of microneurosurgical technique included establishing the diagnosis by neuroradiological studies, planning the smallest approach, and avoiding exploration, to minimize tissue dissection. Williams (14) had unique motivation to employ microlumbar discectomy, namely treatment for Las Vegas showgirls, who could not display more than a one-inch incision or stay out of work more than two weeks.

Research into minimally invasive disc surgery with chymopapain was reported in 1963 by Smith et al. (15). Percutaneous discectomy started with the work of Hijikata (16) in 1977. Arthroscopic microdiscectomy was developed by Kambin (17) in 1983, and Ascher (18) was the first to utilize a neodymium: yttrium-aluminum-garnet laser to ablate the nucleus pulposus through an 18-gauge spinal needle.

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Following the adaptation of nuclear magnetic resonance for viewing the anatomy of the nervous system, the advances in neuroimaging became exponential, including magnetic resonance angiography and 3-dimensional computerized tomography. Today, frameless stereotaxy, sonic digitizers, robotic instrumentation, real-time imaging, and the interfacing of digital and video imaging are becoming part of every neurosurgical training program. Alternating between direct observation of surface features and indirect visualization of deep structures with high-resolution, high-definition systems will further the neurosurgeon's ability to accomplish minimally invasive surgery of the brain and spine.

Yet it would be misleading to focus entirely on noninvasive neuroimaging, miniaturization of instrumentation, and improved intraoperative viewing of lesions. Endovascular stenting and coiling of aneurysms and arteriovenous malformations, stereotactic radiosurgery, implantation of electrodes, simple shunting methods, nonoperative pain management, chemonucleolysis and computerized-tomography-guided needle procedures also further the objectives of minimalism. In the immediate future, gene therapy for cerebrovascular disease and viral treatment of brain tumors may become new standards of minimally invasive techniques in neurology and neurosurgery.

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