The Concept of Minimally Invasive Neurosurgery

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KEYWORDS

• Neurosurgery • Keyhole technique • Minimally invasive
• Neuroendoscopy

All truth passes through 3 stages. First, it is ridiculed; second, it is violently opposed. Third, it is accepted as being self-evident.
Schopenhauer (1788–1860)

From the inception of neurosurgery as a separate surgical discipline, there has been a consistent theme in its teachings, that a bigger opening is better. This concept was dogma until only a few decades ago when it was not uncommon to face insurmountable brain swelling on opening the dura. The conditions resulted from a combination of factors, including the use of volatile anesthetic agents, nonselective vasopressors for controlled hypotension, and poor patient positioning as a consequence of cumbersome operative tables and the inability to ideally elevate a patient's head. With this fear of brain swelling came a general philosophy that the cranial opening should be as large as possible to offset the intracranial hypertension. A secondary reason for unnecessarily exposing large areas of brain was the ability to perform partial or complete lobectomies in the case of recalcitrant swelling. Also, without stereotactic guidance, and, in earlier days, without accurate preoperative imaging, it was necessary to expose as much cortical surface as possible in case the surface landmarks were imprecise. Finally, the most commonly cited reason for rejecting smaller craniotomies was the inability to control hemorrhage through a small hole. Collectively, these fears understandably resulted in the teachings of our forefathers. The most commonly performed cranial opening was the frontotemporal craniotomy using a large question mark incision on the left and a reverse question mark incision on the right. Even other areas of the brain were accessed through large osteoplastic flaps based on the temporalis or the occipitalis muscles. Neurosurgeons in the past did this to expedite the closure in the absence of synthetic bone closing hardware and because a popular dogma at the time was that a vascularized flap was less likely to become infected or necrotic.

In the past 30 years, technological advances have all but eliminated these limitations and fears. Preoperative imaging has become so sophisticated that a surgical approach can be planned with millimeter accuracy, and in some centers on a computerized virtual reality platform. Intraoperative stereotactic guidance may improve that accuracy to the submillimeter and assist with choosing the perfect trajectory to the target lesion. Electric beds with remote controls allow operating room staff to position patients ideally and rapidly even when fully draped. Anesthesiologists are less inclined to use volatile agents and many of the anesthetic drugs used today reduce intracranial pressure rather than increase it. Blood pressure drugs are more selective and less inclined to create cerebral under- or overperfusion. The poor anesthetic conditions once complained of so frequently are a rarity today. Osteoplastic flaps are virtually never performed today because free bone flaps are secured reliably and rapidly with titanium plates. The incidence of infection and bone flap necrosis is low and certainly no higher than that seen with the osteoplastic

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flap. Finally, the fear that hemorrhage is less manageable through a small craniotomy than through a large one has been addressed with better bipolar, nonstick forceps and excellent and effective hemostatic agents.

Despite these advances there is still a school of thought that vehemently rejects exposing less brain than is necessary to achieve the goal of surgery. Many of the arguments revolve around statements, such as "I am concerned with damage to the brain, blood vessels and nerves and not the length of the skin incision" or "My results are excellent, why would I change?" or "Cosmetic results and the length of the incision should not take precedence over neurologic outcome". Clearly, the intention of these resistant surgeons is not to insult those surgeons practicing minimally invasive techniques, but the basic premise of their statements implies that surgeons who are minimally invasive are more concerned with cosmetic outcome than neurologic outcome. This is obviously not the case. Indeed, the intention of the minimally invasive neurosurgeon is to improve patient outcomes. Class 1 data that would show a smaller craniotomy is better than a larger craniotomy will never be attained. To ask minimally invasive neurosurgeons to randomize their patients into two groups, one group on whom surgery is performed through an opening as large as is necessary to achieve the intended result as safely and as efficiently as possible and another on whom surgery is performed with the same goals but through an unnecessarily large craniotomy, will never happen. If a surgeon adopts a new approach and a patient has a worse outcome as a direct result of the approach, then clearly he or she needs to re-evaluate the new approach and modify it or revert to the old approach. The eventual approach will be the most minimally invasive operation whether or not it is 3 cm or 6 cm in diameter, through the nose, or through the cranium. If a surgeon has a 100% success rate and a 0% complication rate doing an operation through an eyebrow incision, however, but could do the same operation through the nose with the same results, then why should not that surgeon include the cosmetic outcome in the surgical treatment algorithm?

The aim of this issue is not to convince neurosurgeons that all intracranial pathology can be treated through a cranial opening the size of a coin; it is to demonstrate the techniques that have evolved out of the minimally invasive philosophy. We firmly believe that by minimizing brain exposure and soft tissue manipulation to the absolute minimum needed to achieve the surgical goals, better patient outcomes may be achieved.