Pediatric Neurosurgery: State-of-the-Art and Future Directions

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Until the early 20th century neurosurgery was practiced only sporadically in children. In 1913, Harvey Cushing arrived at the newly-opened Peter Bent Brigham Hospital, now the Brigham and Woman’s Hospital, as its inaugural surgeon-in-chief. There he operated on children with varying neurosurgical pathologies and then transferred them back to Boston Children’s Hospital (BCH) for their postoperative care. In 1929, Cushing asked his protégé, Franc D. Ingraham (Fig. 1), to begin a pediatric neurosurgical service at BCH. Ingraham thus created the first department of pediatric neurosurgery in the world and became the founding father of pediatric neurosurgery.

Since its origin, pediatric neurosurgery expanded widely across the world. In recent decades, we have seen dramatic advances in neuro-imaging technology, surgical technique and research, focusing on improving the outcome of children with surgical disorders of the nervous system.

In recent decades, the field of Minimally Invasive Neurosurgery has enjoyed widespread popularity. Refinements in optics, computer technology and miniaturization have improved the safety and efficacy of these procedures. Some benefits of minimally invasive (endoscopic) neurosurgery include less surgical invasiveness, reduced blood loss, less postoperative pain and faster recovery. It is important to remember, though, that although these endoscopic procedures are minimally invasive, they are not risk-free.

Endoscopic third ventriculostomy has become an effective method for treating selected forms of non-communicating hydrocephalus. For some forms of complex loculated hydrocephalus, endoscopic technology has permitted simplification of shunt systems and sometimes even the elimination of shunts.

Fig. 1: Franc D. Ingraham, founding father of Pediatric Neurosurgery, Boston Children’s Hospital, Harvard Medical School.
Endoscopic craniosynostosis repair, a novel minimally invasive procedure, combines the technology of neuroendoscopy with postoperative orthotic (headband) therapy. Endoscopic suture release is an alternative to traditional open craniofacial surgery. Advantages of the procedure include smaller incisions, shorter surgical time, decreased blood loss as well as shorter hospital stays and recovery periods.

Refinements in image guidance have added to the efficacy of neuroendoscopy. The combination of neuroendoscopy and neuronavigation has become the state-of-the-art for performing tumor biopsy and resection.

Functional neurosurgery has also exploded in the pediatric field over the past two decades, especially in the management of medically intractable epilepsy and movement disorders such as dystonia. Imaging technology and intraoperative monitoring have improved procedures’ safety and reduced postoperative morbidity. Epilepsy resections can be tailored and done less invasively.

Refinements of stereotactic surgical instruments and techniques have enabled surgeons to target brain structures with improved accuracy. Deep brain stimulation (DBS) is on the horizon as therapy for some forms of dystonia in children. DBS offers a therapeutic option for children with severe primary dystonia and, in selective cases, secondary dystonia. The surgical goal remains to improve the quality of life for the child and the child’s family.

The management of pediatric tumors has undergone major advances in recent years. Refinements of operative technique and improvements in imaging guidance have provided surgeons with better options for surgical planning and management of pediatric brain and spinal tumors. Frameless neuronavigation systems and intraoperative magnetic resonance imaging have optimized the extent of tumor resection and significantly reduced postoperative morbidity. Advances in molecular genetics have helped us better understanding specific tumors pathologies, which can lead to the development of designing drugs that will attack specific targets.

Pediatric brain and spinal vascular disorders are rare but potentially life-threatening conditions. Advances in the understanding of their natural history have enabled us to optimize the management of different pediatric vasculopathies, such as stroke, arteriovenous malformations and moyamoya disease. The optimal management requires a multidisciplinary team of neurosurgeons, neurologists, intensivists, interventional neuroradiologists and pediatricians.

Future directions

The future of pediatric neurosurgery is centered on refining current techniques and introducing novel therapies. There is a call for fresh minds and motivation to redefine minimally invasive approaches that will improve accuracy and efficacy in the management of pediatric pathologies. The future will bring newer, smaller and better instruments. 3-D printing technology will lead to advances in training and in carrying out neurosurgical procedures.

The future of pediatric neurosurgery is centered on collaboration. Advances will come from the joint effort of neurosurgery, neurology and neuroscience research. Technology has made the world a smaller place. Our hope is that collaboration will occur not only among disciplines, but also among nations. It is essential to champion such international scientific collaboration, particularly in this age of political chaos and unrest. We appreciate the efforts of the Egyptian Journal of Neurosurgery to promote this brotherhood of international collaboration.