The Rapidly Advancing Field of Neuro-Oncological Surgery

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Very few surgical specialties have witnessed the level of technological advances at such a rapid pace and a resultant improvement in patient outcomes, as the field of neurosurgery. Neurosurgery is undoubtedly a late bloomer, as for a long time the brain and spinal cord were considered no-go areas, while other specialties were flourishing. When men (men, as neurosurgery remained a single gender specialty for a very long time) did attempt to intervene in neurological illnesses, the morbidity was monumental. Those who survived neurological injury, succumbed to infection, as compared to other organs, brain was found less forgiving when it came to infections. Although, much of the growth of the specialty can be credited to the understanding of human anatomy and the development of surgical skills, major credit goes to the introduction of the operating microscope, and the especially, the development of radiology as a specialty. X-rays, angiography, and later CT and MRI scan completely revolutionized neurosurgery. Of course the improvements in asepsis and anesthesia were the essential pre-requisites like any other surgical specialty.

Neuro-oncology in particular has seen the most exciting introduction of technology in patient care. We can now safely manage all forms of brain and spinal cord tumours, and even though a substantial survival benefit in some forms of brain tumours remains elusive, both the survival and quality of life in all major neuro-oncological pathologies have improved. Preoperative tools such as functional MRI (fMRI) and diffusion tensor imaging (DTI) enable surgeons to assess tumor relationships with functional tissue and provide early diagnostic insight, as well as providing safe surgical corridors [1]. Intraoperative tools such as high-end operating microscopes, navigation with DTI, intra-operative ultrasound, intra-operative MRI (iMRI), sodium fluorescein, 5-aminolevulinic acid and awake assessment for eloquent tumor resection help surgeons safely resect tumours that were once considered unresectable [2]. Robotic-assisted surgeries, although not yet available in developing countries offer even more. Minimally invasive techniques like laser interstitial thermal therapy (LITT) and Photodynamic Therapy (PDT) reduce operative morbidity while providing effective treatment and improving survival [1]. Improvements in radiation therapy and introduction of gamma knife and cybeknife technology has allowed surgeons to treat difficult to resect, or recurrent lesions with ease as well.

The WHO 2021 classification has enhanced understanding of the molecular and genetic foundations of brain tumors, paving the way for personalized treatment based on an individual's tumor genetic profile [3]. Immunotherapy and Tumor-Treating Fields, recently FDA-approved for Glioblastoma, offer new hope with the potential to harness the immune system and disrupt tumor cell division [4].

In future, Artificial Intelligence (AI) platforms have the potential to cause a paradigm shift in neuro-oncological surgery. Although in its infancy, AI when used in brain tumour surgeries can aid diagnosis, optimize surgical plans, provide support during surgeries, and even predict the prognosis. These innovations will one day surely minimize, if not completely eliminate the human factor of uncertainty from the management of these complex pathologies [5].

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