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TITLE: **Role of Endoscopy in Neurosurgery – A Historical Perspective**

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ROLE OF ENDOSCOPY IN NEUROSURGERY, A HISTORICAL PERSPECTIVE

Abstract

Since the first endoscope for minimal access surgery was developed in 1806 there has been a steady improvement in technology available to the endoscopist. The unique perspective that neuroendoscopy offered was not fully realized until key technological advances made reliable and accurate visualization of the brain and ventricles possible. Endoscopic third ventriculostomy and other neurendoscopic procedures are now commonly used to treat a wide array of neurosurgical disease conditions. This has reduced appreciably surgical time, morbidity, mortality, in-hospital stay and ultimately the cost when compared with that of open neurosurgical procedures. In the future, neuroendoscopy is expected to become the routine treatment option in many neurosurgical diseases especially in the third world since it is ultimately cost effective.

Key words: *Endoscopic third ventriculostomy, Minimal access surgery, Neuroendoscopy*

Introduction

The first endoscope for minimal access surgery of any kind was developed by Philipp Bozzini in 1806 for the examination of canals and cavities of the human body. Bozzini wrote, “Until now, we were unable to look into the internal cavities and spaces of the living animal body. The anatomist’s knife taught us only their forms; their functions could only be surmised”[1]. The Vienna Medical Society did not approve of this “technology,” but rather censored Bozzini for his curiosity and rejected his instrument. Max Nitze is credited with designing the first modern endoscope in 1879. According to Schultheiss, et al., this was a crude device composed of a series of lenses with an illumination source at the tip[2].

The history of neuroendoscopy is closely related to the treatment of hydrocephalus. In 1910 Victor Darwin-Lespinasse a Urologist from Chicago first described the use of paediatric cystoscope in choroid plexus cauterization[3]. Twelve years later, Walter Dandy performed, unsuccessfully though, endoscopic choroid plexectomy for hydrocephalus using a cystoscope[4]. Mixter performed the first successful endoscopic third ventriculostomy (ETV) by using a urethroscope in a 9-month-old girl with obstructive hydrocephalus. Mixter’s report, which is detailed in Abbott and Walker, went largely unnoticed, possibly because of the cumbersome size of his instruments and the poor illumination that they offered[5,6].

In the mid 20th century, the limits of neuroendoscopy increased to include many indications. Fukushima reported using flexible endoscope to biopsy tumours in 1978[7,8]. Many surgeons reported excision of colloid cysts, cystic craniopharyngiomas and fenestration of cysts in the next few years.

The endoscope is currently being used for all types of neurosurgically treatable disorders ranging from non-communicating hydrocephalus, intracranial cysts, intraventricular tumours, skull base tumours, craniosynostosis and degenerative spine disease. The diversity of these disorders demonstrates the vast potential of the endoscope in neurosurgery. In the future, one can expect routine use of the endoscope for management of a multitude of neurosurgically treatable pathological conditions, either as the primary surgical approach or as an adjunct.

Equipment

The equipment for neuroendoscopy includes rigid and / or flexible endoscopes, light sources (xenon, halogen), digital cameras, high definition video monitors, instruments, microcautery and lasers. The advances in optics and instrumentation have increased the scope and reach of neuroendoscopy. Neuroendoscopic accessories that have been developed include peel-away catheter, biopsy-grasping forceps, needle to punch and aspirate without contamination, balloon catheter, intracranial Doppler probe, contact Nd:YAG laser endoprobe for coagulation and vaporization, and cavitron ultrasonic surgical aspirator for aspiration of the tumour and blood clot. All these instruments are sterilized in ethylene oxide gas or standard autoclaving machine.

The indications for neuroendoscopy can be broadly classified into intraventricular, oncological and spinal surgery.

Intraventricular surgery

Currently, the most common use of endoscopes in neurosurgery is for the treatment of non-communicating hydrocephalus by endoscopic third ventriculostomy (ETV) (Figure 2). Aqueductal stenoses, both congenital and acquired are generally treated by ETV.

ETV may also be useful in treating complex cases of hydrocephalus which require multiple shunts by communicating the different compartments so that only one shunt is needed. Fenestration of loculated ventricles can also be performed, along with marsupialization and fenestration of intracranial cysts [9-11].

Septum pellucidotomy or septostomy can also be performed endoscopically to treat isolated lateral ventricles[9]. Aqueductoplasty has recently been explored for treatment of the trapped fourth ventricle syndrome and aqueductal stenosis[12,13]. Biopsy and / or excision of intraventricular lesions such as colloid cysts, ependymomas, cysticercosis can also be done endoscopically. All these procedures except aqueductoplasty are presently possible in a centre Ibadan (personal communication) and three centres in Lagos[14].

Neuro-Oncological surgery

With endoscopy, previously inaccessible areas located in the skull base or within narrow cavities can be seen well. The use of the neuroendoscope provides the unique ability to perform tumour resection, tumour biopsy sampling, relief of tumoural obstructive hydrocephalus by ETV, and cerebrospinal fluid sampling for cytology in a single procedure[15-17]. Ventriculoscopy can be more sensitive than MRI with a little added disadvantage of morbidity. It helps in determining the presence or absence of ependymal spread. Management of secondary hydrocephalus by ETV to divert cerebrospinal fluid before the tumour causing hydrocephalus is tackled. The patient can be assessed properly and proper CSF dynamics established before attempting tumour removal. Planning of the surgical approach for these procedures can even be facilitated with frameless stereotactic guidance[18].

Fukushima and colleagues were the first to report the use of the neuroendoscope for biopsy procedures in intraventricular tumors[7,8]. In addition to tumour biopsy sampling, the endoscope has been used for resection of colloid cysts, subependymal giant cell astrocytomas, tectal gliomas, central neurocytomas and choroids plexus tumours[17,19-22]. Tumours with moderate to low vascularity, soft, and small in size are more amenable to endoscopic resection, colloid cysts being the most appropriate for this technique. The endoscopic endonasal transphenoidal approach is applicable to a wide range of sellar tumours, frontobasal tumours, clival chordomas and brainstem related tumours[23]. Neuroendoscopy for skull base tumours began with Carrau and his colleagues at the University of Pittsburgh[24]. De Divitiis, et al. expanded the scope of this approach to include other lesions of the sellar and parasellar region[25]. The bilateral endonasal endoscopic approach now allows for visualization of tumours at the anterior skull base up to the crista galli and down to the level of C-2[26].

Endoscopy in Spinal Surgery

The use of neuroendoscopy has become widespread in spine surgery for indications ranging from degenerative disease to deformity correction. Although at present it is most widely used in minimally invasive spine and thoracoscopic surgery, novel uses continue to emerge in the literature.

It is most commonly used in minimally invasive lumbar spine surgery, lumbar laminotomies, discectomies, anterior approaches for spinal reconstruction, thoracoscopic sympathectomy, resection of tumours and cysts, treatment of thoracic disc herniations and for anterior release and rod placement in the correction of thoracic spinal deformity[27-34]. Through a minimally invasive approach, lumbar and cervical discectomy can be done as day case surgery with good results, minimal morbidity and early return to work.

As technology evolves and more experience is obtained, neuroendoscopy will likely achieve additional roles as a mainstay in spine surgery.

Craniosynostosis Technique

Jimenez and Barone and their colleagues have pioneered the minimally invasive surgical treatment of craniosynostosis [26,27]. Their technique involves the creation of strip craniectomies through the endoscope, followed by application of a molding helmet to recontour the cranium. Using a strictly endoscopic approach, they have reported a low rate of complications and good success rates.

Furthermore, the rate of blood transfusion in their most recent report was only 9% in 139 patients.[27]

Current Status

About 2 years ago, neuroendoscopic procedures started in Nigeria with a steady increase in the number and diversity of procedures done. It is an extremely rewarding experience to make a patient shunt free[14]. Neuroendoscopy as a form of minimal access surgery is generally associated with significantly reduced surgical time, morbidity, mortality, in-hospital stay and ultimately the cost when compared with that of open neurosurgical procedures. In a developing country like Nigeria where cost plays a dominant role in patient management, neuroendoscopy should be embraced whole heartedly by health policy makers.

Conclusion

In the nearest future, routine use of the endoscope for management of multitudes of neurosurgical diseases is certain, either as the main surgical approach or as adjuvant treatment. As technology evolves, appropriate training, including updating and experience are important to keep up with the global change and ensure the success of the procedure and avoid complications.

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