Review Article

Brain Endoscopy, a big neurosurgical revolution

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ABSTRACT

Endoscopy is a rapidly growing field of Neurosurgery, it is defined as the applying of endoscope to treat different conditions of brain pathology within cerebral ventricular system and beyond it, endoscopic procedures performed by using different equipment and recording system to make a better visualization enhancing the surgeon's view by increasing illumination and magnification to look around corner and to capture image on video or digital format for later studies.

Keywords: Brain, endoscopy, revolution.

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First evolution: The first stage of Brain endoscopy was in 1910 when L'E spinsse "a Chicago urologist" inspect the ventricular system of two hydrocephalic patients and perform endoscopic coagulation of choroid plexus to treat hydrocephalus [1-2].

Next significant attempt was by Dandy who applied the term ventriculostomy "endoscopic inspection of the cerebral ventricles" in 1922 [1-2], he use the frontal approach to performing lamina terminalis and hence making a communication from basal ganglia and third ventricle to treat obstructive hydrocephalus, further attempt was by Jason Mixter in 1923 who perform the first endoscopic third ventriculostomy (ETV) using the already open fontanel of a pediatric hydrocephalic patient to reach the dilated ventricle, passing to the third ventricle through interventricular foramen then making fenestration and communication between the third ventricle and basal cisterns, a procedure that reverse in approach to Dandy procedure.

Multiple stages and advances performed within the last century with great expanding in the last decade with the use of brain endoscopy to perform different kinds of procedures for even beyond the cerebral fluid space.

Equipment: It includes endoscopic fixation arms, endoscopic instrumentation including a pair of Grapping forceps and scissors, a monopolar or bipolar coagulation device, an irrigation system and video camera and recorder system. A frameless computerized neuronavigation with CT or ultrasonographic guidance has been used to make more accuracy of the endoscopic procedures

Indications and Procedures: Endoscopic third ventriculostomy: A safe and effective procedure to manage obstructive hydrocephalus with the obstruction at the level of the posterior third ventricle or distal to it including congenital or acquired aqueductal stenosis [3-5].

ETV is also indicated to treat obstructive hydrocephalus secondary to cerebellopontine angle tumors (CPA tumors) and posterior fossa tumors (PFT) as a significant number of them will develop progressive hydrocephalus either at presentation or following irradiation [4, 6, 7]. Hydrocephalus secondary to pineal tumors is a good candidate for ETV that will be discussed later [7-9].

The procedure of ETV approached by doing coronal burr hole with a position at 3 cm lateral to midline, 1 cm anterior to coronal suture [10]. Endoscope pass through the burr hole to the lateral ventricle the identifying the interventricular foramen (foramen of Monro) by thalamostriate vein and the choroid plexus, passing through it to the third ventricle, inspecting the ventricle then performing perforation at the floor of the third ventricle posterior to infundibular recess of pituitary stalk posterior to mammillary bodies, perforation could be sharp or blunt each with its own complications [2].

It is important to be noticed that anatomy could be altered by a tumor displacing the Basilar artery or in previously shunted patients [2]; however, third ventricular ultrasonography may be helpful to identify ventricular and vascular anatomies making details anatomical information including foramen of Monro and floor of the third ventricle, other guidance available by use of intraoperative MRI and CT scan neuronavigation[11-16], knowing these anatomical variations along with identifying site of obstruction make it possible to perform optimal localization for burr hole site [17].ETV shows a high success rate related to traditional shunt procedure with an overall success rate of 75% after 3 years [2], with a rate of 100% in infants in some centers [1]8. ETV after shunt malfunction shows a success rate of 64%,

however, it is still better in safety than traditional shunt procedure [18-21].

High success rate depends on the selection of patients with normal ventricular anatomy with thin membrane

while patients with thick membrane and obscured anatomy show high failure rate [22].

Removal of intracranial cyst : Including many types of cysts such as arachnoid, colloid, infected "hydrated and cysticercosis", pineal, Rathke cleft cyst, craniopharyngioma and neoplastic cysts [2, 23-29]. Such removal is indicated to treat obstructive hydrocephalus resulted secondary to a cyst and to remove the cyst lesion of pathology as in irradiation or debulking of a neoplastic lesion. Endoscopic removal of cyst considered safer than traditional craniotomies and stereotactic procedures due to direct visualization of capsular vascularization and consistency [23], removal could be done purely endoscopically or as a combined treatment with microsurgery or radiation therapy [23].

Arachnoid cyst: the usual treatment of arachnoid cyst is a ventriculoscopic fenestration [24-25], it shows a better result to craniotomy and shunting procedures, safest and less invasive with a high rate of complete radiological resolution leaving the patient shunt independent [24-28].

Colloid cyst: also treated endoscopically by fenestration with safe and effective results, however, an Italian study group shows asymptomatic recurrence of 11.4% on long term results making a controversy and the traditional therapy of craniotomy and microsurgery remain open [29]. A new technique provides more radical resection by a CT-guided biportal endoscopy offering complete removal of colloid cyst [30].

Pineal cyst: pineal tumors are rare tumors of central nervous system with an incidence of 1-3.2% occurring both in children and adults including high varieties of pathologies which could be cystic, solid or mixed with secondary obstructive hydrocephalus [2, 8-9]. Techniques including ETV to treat secondary hydrocephalus and biopsy taking through transventricular approach, or transnasaltranssphenoidal for bifocal tumors with intrasellar component [8-9, 31-33].Cystic craniopharyngioma could be treated through a transventricular approach in addition to other endoscopic approaches; it is an effective but a palliative procedure for primary or secondary cases [34-36]. Intraventricular and subarachnoid basal cisterns neurocysticercosis (rare presentations of the commonest parasitic disease of the central nervous system) can be treated endoscopically removing most of parasites with removal or placement of shunt when needed [37-38], other CNS infections manifested as brain abscess could get some benefit from endoscopy to make sure that the pus has been removed making it a possible alternative to stereotactic aspiration [39].

Other rare pathologies are septum pillucidum cysts, the endoscopic procedure for them performed through making fenestrations of the septum pillucidum (septum pillucidotomy) providing communications between cysts and ventricles and thus avoiding the need to shunting or craniotomy [40].

Hydrocephalus management through foraminalplasty: This includes endoscopic aqueductoplasty and foraminoplasty of the foramen of Monro. Endoscopic aquiductoplasty is indicated for patients with primary or secondary membranous aqueductal stenosis with a stent may be used in the procedure, it is mainly used when ETV is not possible as it is more dangerous with a high risk of re-stenosis and stent migration even years after endoscopic procedure done [41-42]. foraminalplasty of the foramen of Monro may be indicated in isolated unilateral hydrocephalus due to membranous occlusion [43].

Simplification of septated or loculated hydrocephalus and other related conditions : Such cases result from compartments formation secondary to infections or intraventricular hemorrhage in preterm infants; it may require multiple shunt placements with a high failure rate with subsequent infections. Endoscopic procedures in such cases aim to make communications between CSF compartments or between the two lateral ventricles through making fenestrations of compartments or septum pillucidum respectively [2].

Another option to treat hydrocephalus in some selected patients is by coagulation of choroid plexus especially for those patients with slowly progressive, a severe form of hydrocephalus and those who lack septum pillucidum[44].

Treatment of a vascular aneurysm and intracranial hematoma : First attempt by aneurysmal lesion management by endoscopic-assisted microneurosurgery was in 1994 by Fischer and Mustafa; they use fibroscope to enhance visualization, a rigid endoscope used later with a better visualization to clarify structures surrounding aneurysm including neck of an aneurysm, feeder artery and any perforating branches and to visualize posterior wall of it with structures hidden behind it [45-46]. It thus improves quality of surgery make it safer especially if an aneurysm obscures its feeder artery or the aneurysmal lesion located in a narrow space be minimizing the need for retraction. Patients with aneurysm of internal carotid artery and anterior communicating artery are the best candidates for endoscopic-assisted microneurosurgery.

Evacuation of hematoma was first reported by Auer in 1985 as a safe and less invasive procedure than craniotomy; however, collapse of the cavity after evacuation result in limited visualization minimizing complete hematoma evacuation with high recurrence rate due to improper hemostasis, such condition could be resolved by inflation - deflation method with combined irrigation coagulation suction tube (a procedure done by Japanese neurosurgical group) allowing complete evacuation and hemostasis [47].

Endoscopically assisted microneurosurgery: New advances developed in microneurosurgery by using an endoscope to provide the advantages of minimizing retraction and enhancing visualization by reaching

inaccessible or poorly accessible areas such as skull base, narrow areas or areas behind or adjacent to important vascular or neuronal structures [48-49].

Endoscopic transsphenoidal surgery is the most important example of using the transsphenoidal route to resect pathologies in the sellar region with or without suprasellar extension with more advantages over traditional bifrontal craniotomy and transsphenoidal microsurgical approach (pituitary adenoma as a common sellar pathology) [49]. A complete pre-operative evaluation is essential including Magnetic Resonance Imaging (MRI) of Brain, Axial and coronal CT scanning of the pituitary area, nasal cavity and Para-nasal sinuses describing the bony anatomy, endocrine evaluation and visual examination including acuity, field, and fundoscopic examination. A procedure to be started with the aid of lateral fluoroscopic equipment (C-arm) to provide lateral images of the nasal cavity pre-operatively [48-50]. A rigid endoscope is introduced via one nostril, usually, the wider side of the nasal cavity is selected, a small exception by the use of two nostrils in the case of narrow nasal airways that prevent passage of both endoscope and operating instruments. The anterior wall of the sella is reached and exposed with the aid of ENT surgeon and opened by microdrill or curette exposing the Dura that will be opened by making a cruciate incision [48].

After identifying the adenoma, removal is done by rongeur, straight and curved suction cannulas and pituitary curettes. As the visualization is very good, a tumor with parasellar extension could be removed endoscopically. The cavernous sinus, tuberculumsella and upper third of the clivus could be approached endoscopically[48, 50]. Endoscopic-assisted microvascular decompression for trigeminal nerve or facial nerve is the other important examples with a major advancement in the visualization of nerves and adjacent structures providing high success rate [51-52]. A retrosigmoid burr hole is performed through which the endoscope is passed either through lateral aspect of the cerebellar tentorial surface to the trigeminal nerve in cases of trigeminal neuralgia or through the petrosal surface of the cerebellum to the facial nerve in cases of hemifacial spasm then transposition of nerve done, the ability to look behind the corner make it possible to avoid damage to perforator arteries and so make it superior to traditional retrosigmidal approach [51-52].

Rules in tumors and base of skull: The endoscope has a major role in intracranial space occupying lesions in managing secondary obstructive hydrocephalus by ETV (discussed earlier in the article) and by enhancing tumor removal or taking biopsy especially in the case of pituitary adenomas and intraventricular or tumors adjacent to ventricular walls [16, 19,48, 49].

In the base of the skull, the endoscope has a major rule in repairing anterior skull defects in management cerebrospinal fluid rhinorrhea with a higher success rate and less morbidity and hospitalization compared to traditional intracranial approaches, the endoscopic procedure should be considered the first choice for repairing many of cerebrospinal fluid leak and skull base defects [53,54].

Conclusions :Brain endoscopy is safe and effective in managing different neurosurgical conditions, its safety through making a better visualization making it possible to look around corners and to reach distant structures behind or around lesion thus minimizing possible injuries to them with little or no retraction needed and thus decrease morbidity and mortality.

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