39 Neuroendoscopy in Developing Countries: Mobile Neuroendoscopy Centers

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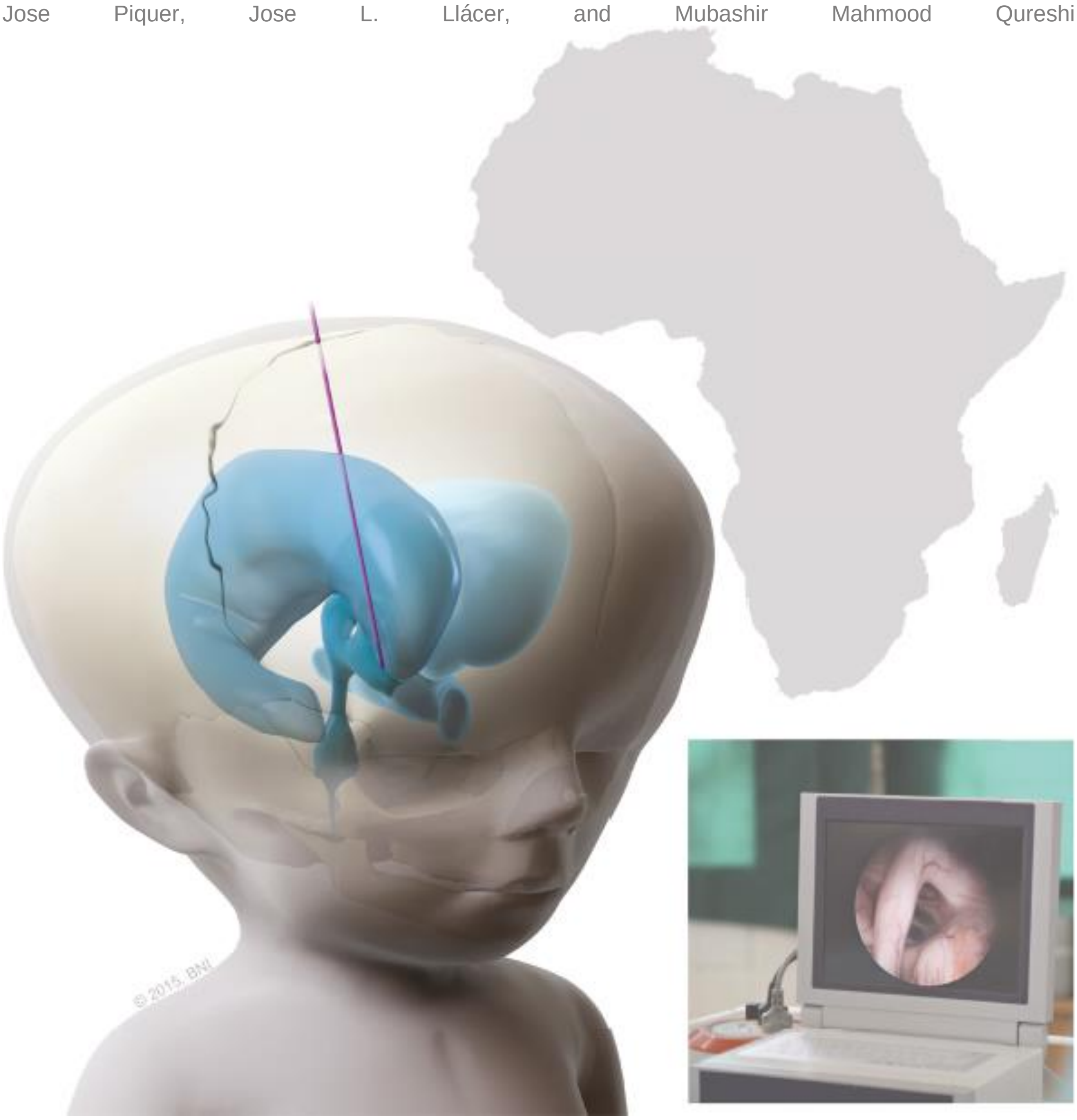


39.1 Introduction

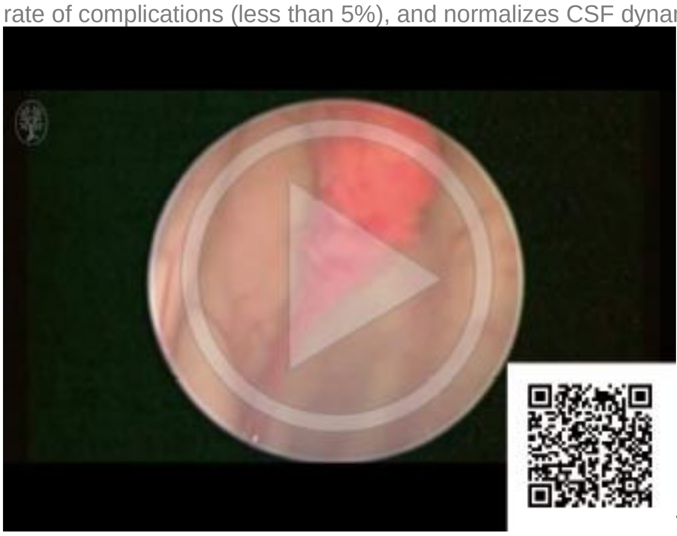
Endoscopic neurosurgery was introduced at the turn of the twentieth century to diagnose and treat hydrocephalus,[1,2] a potentially life-threatening condition listed among the dominant pathologies of the central nervous system (CNS) in developing countries.[3] A conservative estimate suggests an annual incidence of more than 14,000 cases of infants developing hydrocephalus within their first year of life in East, Central, and Southern Africa (ECSA), which has a combined population of more than 250 million.[4] This number shows the enormous burden of the condition in developing countries, compared with developed nations prevalence of 0.9 to 1.2 cases per 1000.[5] Prenatal health care continues to be poor in many developing countries, and reports have suggested that in Central Africa the most common causes of hydrocephalus are neural tube defects and congenital aqueductal stenosis.[6,7] In Zambia, meningitis and other CNS infections account for almost 75% of hydrocephalus cases.[8] Clinical series from East Africa have shown that meningitis and/or ventriculitis is the most common cause of hydrocephalus in East Africa, accounting for almost 60% of the cases.[9] The high prevalence of hydrocephalus in developing countries could be related to untreated or poorly treated neonatal meningitis and nutritional deficiencies during pregnancy and infancy.[10] Although universal access to health care and treatments considered basic in developed countries has yet to be achieved, general improvements in nutrition and health care have resulted in a reduction of the under-5 child mortality rate (U5MR).[11] In recent years, urban, middle-class African families have seen improvements in female education, better infant nutrition and hygiene, and, therefore, a lower U5MR than the regional average.[9] Nonetheless, health care in the less developed regions is a challenge, and specialties requiring highly trained professionals and sufficient access to expensive equipment and supplies is severely lacking in developing countries. The figures, in this regard, speak for themselves. A survey sponsored by the World Health Organization in 1998 revealed the existence of only 79 neurosurgeons in sub-Saharan Africa, a ratio of 1 to 3,600,000 inhabitants, while the world ratio is 1 to 230,000 inhabitants.[3]

Children born with hydrocephalus in developed societies are likely to receive surgery in the immediate perinatal period.[4] However, management of hydrocephalus in developing countries is challenging; parents or caregivers often do not seek medical attention for at least 7 months after onset of clinical symptoms.[12] Less than 5% of children with hydrocephalus in developing countries receive surgery each year, usually consisting of placement of a ventriculoperitoneal shunt (VPS). In Kenya, one of the more progressive nations, less than 25% of affected children will undergo VPS surgery.[4]

39.2 Neuroendoscopy in Developing Countries

39.2.1 Rationale

In the setting described above, where patients are often unable to visit health centers regularly, VPS can be an extremely troublesome device.[13] Shunt surgeries are associated with a higher rate of complications than any other commonly performed neurosurgery procedure, including obstruction, infection, and cerebrospinal fluid (CSF) over-drainage.[12] Additionally, VPS creates lifetime dependency and needs periodic monitoring. In a situation where access to specialized health centers is often difficult, follow-up and management of patients with VPS failure is often impossible, and general practitioners are often unqualified to manage VPS complications.[14] For most patients with hydrocephalus, neuroendoscopy simplifies their treatment and eliminates the need of a VPS. Neuroendoscopy is useful for several procedures in developing countries, the most common being endoscopic third ventriculostomy (ETV) **(Video 39.1)**. ETV is a minimally invasive alternative that cures the diseases in up to 80% of cases.[13,15,16,17] In experienced hands, it has a low rate of complications (less than 5%), and normalizes CSF dynamics.[4,18,19,20,21]



Video 39.1 Neuroendoscopy in developing countries. This video demonstrates intraventricular abnormalities found in patients with hydrocephalus in developing countries. First a standard endoscopic third ventriculostomy is performed in a patient with congenital hydrocephalus. A second patient presented with congenital hydrocephalus with multiple congenital septum pellucidum fenestrations, absence of roof of the third ventricle, aqueductal stenosis, and atrophic choroid plexus. Next, an endoscopic third ventriculostomy and endoscopic exploration are performed using portable neuroendoscopy equipment. The use of a mobile neuroexoscope is also demonstrated in this case of a patient undergoing myelomeningocele repair. A demonstration of a mobile operating room in Africa is included. Dr. Jose Piquer explains the origin, objectives, and future of Neurosurgery Education and Development (NED) Foundation. Dr. M. Mahmood Qureshi (Kenya), member of the NED, explains the needs of neurosurgery in certain regions in Africa.

Although not exclusive to Africa, hydrocephalus treatment has been widely discussed in the context of this continent. In the 1940s and 1950s, Jarvis described options and problems following his experience in Nairobi, Kenya, where he performed four operations using closed ETVs.[22] At that time, substantial surgical success with any technique was still dependent upon advances made in imaging over several decades. Outcomes in shunt surgery during the 1960s in Zimbabwe on 153 children with hydrocephalus were very disappointing; 63% of patients died.[23] In the mid-1990s, the number of procedures and the electronic equipment available increased slightly, and local design of an inexpensive and effective valve for hydrocephalus was used. However, families still needed to make long and costly trips to bring their infants from outlying districts for clinic visits, and due to the social situation, trends similar to those of earlier decades were observed: urban children from a more educated environment showed good results, but mortality rates as high as 20% were recorded among children living in rural districts.24 The beginning of the twenty-first century has seen improvements in neuroendoscopic technology, and ETV for hydrocephalus is a promising technique that might be reintroduced in East Africa25 following the recent experience of Warf and colleagues in this region.12,19,26

With the development of endoscopy, and particularly the availability of mobile endoscopes, ETV and other endoscopic procedures are encouraging alternatives in these countries.13,15,16

39.2.2 Training, Equipment, and Organizations

The special needs of these countries have raised awareness beyond their frontiers. In countries with so few neurosurgeons, local training is the best option, since many students educated abroad may choose to remain in Western countries after finishing their training, or find it difficult to adapt to the real conditions in their home countries.3 With this in mind, some international organizations have developed neurosurgery training and supply programs led by expert volunteers in collaboration with local organizations. These initiatives, such as that of the Weill Cornell Medical College (New York, NY) in Tanzania or the wider programs of the Foundation for International Education in Neurological Surgery (FIENS) have obtained good results. In the field of neuroendoscopy, the Neurosurgical Education and Development (NED) Foundation, at the request of FIENS and following preliminary trials in 2006 **(Video 39.1)**,20,27 launched a major training program that now includes several ECSA countries (Kenya, Uganda, Ethiopia, Tanzania, Rwanda, Zimbabwe, and Sudan). This program is aimed at training local neurosurgeons and nurses in different hospitals and countries in subSaharan Africa to perform endoscopic procedures. Access to equipment is obviously a crucial limitation in this setting, and the availability of portable neuroendoscopic equipment has been the keystone of this project.4 Recent experience with a device consisting of a display unit with a camera and a light source that can be easily transported in a single suitcase has yielded excellent results both in terms of successful outcomes and training local staff to use this equipment on a regular basis.4,20,21 This system partly compensates for the shortage of qualified personnel, since it can be used by a single local surgeon traveling over a large region, visiting several hospitals, and also reaching rural areas **(Fig. 39.1)**.

Fig. 39.1 The neuroendoscope OI Handypro (Karl Storz Co.) can be used with one hand. It allows the surgeon to safely perform the endoscopic fenestration without assistance.

39.2.3 Clinical Evaluation of Hydrocephalus and Diagnosis Limitations in Developing Countries

Several difficulties are often encountered when evaluating patients in developing countries. The most common are the lack of clinical or family history, the difficulty in obtaining clinical images (either unavailable or poor quality), and the lack of access to some complementary tests. This may be combined with communication problems, either due to minority languages or, in the case of foreign visiting neurosurgeons, lack of knowledge of the local language, raising the need for local interpreters. Magnetic resonance imaging (MRI), a standard preoperative imaging modality in developed countries, or computerized tomography (CT) is not usually available, since this kind of equipment is far beyond the economic resources in the region,3 although ultrasonography may be available for preoperative imaging. In these situations, anamnesis is the most useful tool for the surgeon and should include head circumference, fontanel, age at onset of hydrocephalus, history of febrile illness with or without seizures, and time of occurrence. Symptoms of elevated intracranial pressure, such as irritability, vomiting, and headache, should be ascertained along with other symptoms, such as spasticity and/or impaired gait, ocular symptoms (sunsetting or sixth nerve palsy), and the child's developmental progress.12 Infectious cause can be suspected if the history is not consistent with hydrocephalus at birth or if febrile illness and/or seizures preceding the onset of apparent hydrocephalus are reported. If available, ultrasound imaging of septations or loculations, anatomical distortion, or intraventricular deposits will also indicate an infectious cause. Warf defined the cause of hydrocephalus in each patient as postinfectious hydrocephalus (PIHC), non-postinfectious hydrocephalus (NPIHC), or hydrocephalus associated with myelomeningocele, with subclassifications according to age and anatomy **(Table 39.1, Video 39.1)**.

Table 39.1 Hydrocephalus classification and success rates

Categories (etiology)	Subcategory	Age (yr)
PIHC/NPIHC/Myelingocele	**A**	< 1
	B	≥ 1
	C	< 1
	D	≥ 1
Success rates	**Etiology**	**Age (yr)**
Success by etiology and age	PIHC	< 1
	PIHC	≥ 1
	NPIHC	< 1
	NPIHC	> 1
	Myelingocele	< 1
	Myelingocele	≥ 1
	OVERALL SUCCESS	

Abbreviations: PIHC, postinfectious hydrocephalus; NPIHC, non-postinfectious hydrocephalus.
Source: From Warf 2005.12

ETV is recommended as the treatment of choice for all children with hydrocephalus older than 1 year, and for patients under 1 year who suffer from PIHC with aqueductal obstruction.12 Success rates in each group as described by Warf are summarized in **Table 39.1** . We must also mention the extraventricular intracisternal obstructive hydrocephalus that would explain the successful ETVs in cases where a communication between the ventricles and the subarachnoid space is presumed after hemorrhagic or infectious posterior fossa inflammation arachnoiditis. Kehler and Gliemroth observed in preoperative MRI dilated ventricles with a downward bulging floor of the third ventricle (interpreted as a sign of a pressure gradient between the ventricles and basal cisterns) and a free communication to an enlarged cisterna magna. Their hypothesis of an intracisternal CSF pathway obstruction (e.g., between the cisterna magna and the prepontine cistern) could explain the MRI findings with an enlarged fourth ventricle, although such an obstruction cannot be directly visualized28 **(Fig. 39.2)**. Unfortunately, preoperative imaging is usually unavailable, and observations need to be performed *intraoperatively*, which sometimes leads to interruption of the procedure if anatomical abnormalities that cannot be overcome are observed. Therefore, intraoperative neuroendoscopic imaging is crucial.