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Peer-Review Report

Mobile Endoscopy: A Treatment and Training Model for Childhood Hydrocephalus

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Background

Hydrocephalus, largely a disease of poverty in many developing regions such as Sub-Saharan Africa, becomes even more challenging to treat because of lack of trained neurosurgical personnel, inadequately equipped public health care facilities, meager resource allocation, high rates of neonatal infection, difficulty of access to tertiary care hospitals able to treat hydrocephalus, and high complication rates in patients who are able to access and receive shunting procedures. Furthermore, conventional methods of training of neurosurgeons and nursing staff to become proficient in neuroendoscopic procedures involve a lengthy period of training, often at specialized centers in Western or local Western-style institutions.

Methods

The novel approach promoted by volunteer neurosurgical teams from Neurosurgery Education Development Foundation is described, and its potential role in successfully providing neuroendoscopic ventriculostomy at hospitals in regional sites away from main referral tertiary hospitals is outlined. The impact on the training of local neurosurgical specialists and residents in training as well as nursing staff is highlighted.

Results

With the use of a single portable neuroendoscopy system and a versatile free-hand, single-operator neuroendoscope, this outreach, mobile, and readily portable model has been

successfully used to perform more than 250 procedures in 21 different hospital sites around seven different countries in two continents. The local courses have imparted hands-on training to 62 neurosurgeons and trainee residents and a further 110 operating room nurses at these 21 institutions.

Conclusions

Neuroendoscopy is not only a priority surgical tool for East Africa. It offers a medical philosophy as an application that serves as an art and a science dedicated to the development of a complex surgical specialty: neurosurgery.

Introduction

Hydrocephalus is a potentially life-threatening condition that affects between 0.5 and 2 per 1000 live births. It is an enormous burden in developing countries worldwide. In East, Central, and Southern Africa region, with a combined population of more than 250,000 million, a conservative estimate suggests an annual incidence superior to 14,000 infants developing hydrocephalus within the first year of life.

Children born with hydrocephalus in Europe, United States, Japan, and other Western societies are like to receive surgical attention in the immediate perinatal period or as soon as possible, aimed to prevent consequent cerebral damage from increased intracranial pressure. In Kenya, one of the more progressive nations in the East, Central, and Southern Africa region, less than 25% will undergo surgery (500–600 cases of the approximately 2000 hydrocephalic children born annually). These “fortunate” few receive shunting procedures, with the attendant risks of shunt infection and blockage (as high as 25%). The remaining three–fourths of cases annually remain the unfortunate ones who do not get a chance of receiving treatment, denying them any chance of a useful survival, if they are to survive at all.

In this situation “many parents have tried to hide their children's condition from friends, neighbors, and extended family. The birth of a child with hydrocephalus was taken as a personal failure which must be concealed … pressure was exerted on mothers by their families to get rid of the hydrocephalic child by abandonment in the bush … … in the face of such pressures it is unsurprising that all the mothers of the children who died expressed relief rather than sorrow” (8). Twenty-five years later, African children and their desperately helpless parents still face immense difficulties.

The primary aim of treatment for hydrocephalus is normalization of impaired cerebrospinal fluid (CSF) flow, aimed at achieving a state of “arrested hydrocephalus” (1, 6). The final goal after treatment is defined as “shunt-dependent arrested hydrocephalus” in cases of shunt placement or “postventriculostomy-arrested hydrocephalus” after neuroendoscopic ventriculostomy procedures.

Of the large number of patients developing hydrocephalus within the first year of life, only approximately one-fifth of the overall number have access to shunting procedures in established centers in Kenya, and an even lower number do in other countries within this Sub-Saharan region, with the majority being treated by a handful of neurosurgeons, a few general surgeons, and occasionally by pediatric surgeons.

Shunts are expensive to purchase by the family and often are unavailable altogether. However, even when low-cost, affordable shunts are used, shunt failure through infection, shunt blockage, distal migration, scalp erosion, and shunt extrusion through anal passage or oral extrusion (**Figure 1**) are significant causes of morbidity and mortality in up to 25% of the treated patients (5). Thus, in developing regions, shunt-placement procedures and shunt dependency pose an additional burden on the health care systems as well as on the care receivers and indeed upon the handful of specialist care providers, whose time is further expended in managing the disproportionately high rates of complications of shunting in these environments.

It is therefore better to pursue a definitive approach to treating hydrocephalus while at the same time avoiding shunt dependency. Neuroendoscopic ventriculostomy (NEV) has the advantage of achieving normalization of CSF flow dynamics and avoiding shunt-related morbidities and dependency in the majority of children (2, 3). The equipment used for NEV in centers able to provide this service includes a camera control Unit, a cold light source unit, a high-frequency electrosurgical cautery unit, and a flat screen monitor display unit, all placed on a mobile cart riding on casters that also incorporates shelves and drawers (**Figure 2**).

The use of this set of equipment, albeit very robust and mobile within an operating suite of individual hospitals, is restricted to the provision of NEV procedures only to those patients who are able to reach the hospital facility. It cannot be a conveniently and readily accessible service to patients in low economic profile regions, where the purchase cost of providing such equipment in distant and rural settings is neither feasible nor affordable, nor is it safely and easily transportable. This means that the large majority of patients who reside in rural communities cannot be offered the preferred mode of treatment, the use of NEV procedures.

In November 2006, the neurosurgical section of the Neurological Society of Kenya and Neurosurgery Education and Development Foundation (NED) commenced a program of teaching and promoting neuroendoscopic management (endoscopic third ventriculostomy) by using a mobile system as the best solution to resolve this health and humanitarian problem. NED's neurosurgeons (J.P., M.Q., P.H.Y.) developed a project through neuroendoscopy workshops, aimed at the treatment of hydrocephalus through neuroendoscopy and promoting the training of neurosurgeons and residents in training in the 12 countries of East, Central, and Southern Africa. Thus far, the program has held hands-on courses in Kenya, Uganda, Tanzania (including Zanzibar), Ethiopia, Rwanda, and Sudan.

The Association of Physically Disabled of Kenya, a charitable nongovernmental organization that has a network of more than 280 outreach screening and treatment clinics countrywide,

has also joined the effort as a partner specifically for the hydrocephalus/spina bifida program, helping to select and refer the cases for screening.

The goal is to train local neurosurgeons and nurses in the treatment of hydrocephalus by neuroendoscopy. It is a hugely attractive alternative that can cure up to 70% of cases without the need of a shunt. With the use of a single portable NED-funded endoscope, a much greater number of patients can undergo the procedure at a fraction of the cost (which is free to the patient; at US $200 per shunt, this equates to the price of 15 shunts), with better results and fewer complications. In addition, if the intervention is effective, the patient no longer requires long-term medical monitoring because he or she is cured. It therefore seems logical that any hydrocephalic child in most parts of Africa should have, as a first option, the opportunity to be treated by neuroendoscopy.

Section snippets

Materials and Methods

In August 2006 the first neuroendoscopy workshop was conducted in Kenyatta National Hospital (Nairobi, Kenya). After this initial course, a neurosurgical team that had established an outreach mission program to provide specialized neurosurgical services in regional hospitals outside the capital Nairobi (**Figure 3**) purchased a compact Karl Storz Telepack neuroendoscopy system (**Figure 4**), which includes a processing unit, combined with a camera unit and light source, all conveniently and safely...

Results

In tandem with providing an opportunity of treatment through NEV for more than 250 patients (**Figure 6**), by August 2010, the program had become a source of training of local teams, both neurosurgical and nursing, in performing the NEV procedure, sterilization, and care of the equipment. The same single equipment system has been used in seven countries to train 62 MDs (**Figure 7**), including neurosurgeons and neurosurgery residents, to learn the procedure through hands-on courses, and 110 operating ...

Discussion

Several decades ago in Nairobi, Kenya, Jarvis (4) described current surgical options for hydrocephalus and their problems in developing countries when closed third ventriculostomy was used. Decades later, after developments in imaging and endoscopic equipments, a mobile neuroendoscopy teaching program designed by NED foundation enabled East African surgeons to understand more clearly what was going on inside the head of a child who was hydrocephalic. In addition to providing a better...

Conclusion

The outreach portable neuroendoscopy model developed in Kenya and now being promoted across the broader East African region is one that can achieve the objectives of NEV treatment with ease, safety, convenience, and in a cost-effective manner. Its main requisites are a recognition that NEV is a preferred option of management, equipment that is readily portable in a safe and reliable way, and a dedicated team willing to volunteer its time and skills to, not only to provide care, but also to...

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> ...Furthermore, there is little region-specific research to facilitate evidence-based medicine and innovation. However, some noteworthy exceptions include research into different types of valves for hydrocephalus (Chhabra valve),8 development of hydrocephalus treatments that do not rely on implantable hardware (CPC/ETV),72 or adapting existing technology to become mobile and therefore more widely available in rural communities (mobile endoscopy).20,21 The above studies have not only been well executed; they constitute a true innovation in neurosurgical care with the potential to influence East African communities....

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