Original Article

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Scope of pediatric neurosurgery unit in a neurosurgical referral center of a low-income country: survey of caseload and "take-home" actions provided by rotation at United States pediatric hospital

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Abstract

Introduction: Nepal's population is 30 million, and 28% are under the age of 14. There are only 116 neurosurgeons, with none specifically committed to pediatric neurosurgical practice, nor is there a dedicated pediatric neurosurgery center. Consequently, there is an immediate need for developing pediatric neurosurgery practices, requiring analysis of the most prevalent neurosurgical disorders endemic to Nepal to identify areas of treatment focus, in addition to training for pediatric neurosurgical subspecialists.
In response to these needs, we present our initial experience surveying the current pediatric neurosurgical caseload at the tertiary referral center in Nepal and summarize key learning points derived from a visiting rotation at a high-volume United States (US) pediatric neurosurgical practice.

Materials and Methods: Retrospective case analysis at a tertiary level neurosurgical referral center in Nepal; all operative cases 18 years of age or younger over a 5-year period were included, categorized by pathology and treatment. Following this, a three-month rotation at Boston Children's Hospital (BCH) was subsequently reviewed to identify key learning points relevant to impacting practice upon return to Nepal.

Result: There were 601 cases performed during the 5-year period. Male to female ratio was ~2:1. Common operative cases included trauma, hydrocephalus, tumors, brain abscesses, vascular malformations, craniovertebral junction anomalies, spinal dysraphism and seizure. With a focus on these conditions, rotation lessons from BCH were identified to improve treatment of these specific conditions in Nepal, with major learnings in operative efficiencies and resource allocation. The learning was applied to make changes in practice in the hospital.

Conclusion: This work provides a current review of pediatric neurosurgery in Nepal and has highlighted the common neurosurgical treatments provided. These data will direct future areas of focus for training and resource allocation for planning a dedicated unit in Nepal. In addition, the experience at the US teaching hospital has led to the development of novel treatment strategies upon return to Nepal.

Key words: pediatric neurosurgery, scope, subspeciality, low-income country

Introduction

The latest census reports that Nepal's population is ~30 million, and 28% are under the age of 14.[1] There are only 116 neurosurgeons officially registered with Nepalese society of neurosurgeons.[2] However, there are none specifically committed to pediatric neurosurgical practice, nor is there a dedicated pediatric neurosurgery center in the country. Consequently, this puts children at greater risk of adverse clinical outcomes.[3]

Relevant to these data, sub-specialization in neurosurgery is now beginning in Nepal.[4] There is an immediate need for developing pediatric neurosurgery practices, requiring analysis of the most prevalent neurosurgical disorders endemic to Nepal to identify areas of treatment focus, in addition to training for pediatric neurosurgical subspecialists. Having dedicated neurosurgeons with specialty-specific training in pediatrics improves outcomes, with evidence supporting this approach published citing examples from other low and low-mid income countries.[3] This practice is common in higher income countries like the United States and Switzerland, with longstanding dedicated training and services in pediatric neurosurgery shown to improve outcomes.[5]

In response to these needs, we present our initial experience surveying the current pediatric neurosurgical

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caseload at the tertiary neurosurgical referral center in Nepal and summarize key learning points derived from a visiting rotation at a high-volume US pediatric neurosurgical practice. We also highlight what steps have been taken following this learning experience in order to provide a potential model for others to learn from.

Materials and Methods

To characterize case load and quantify need, retrospective case analysis at a tertiary level neurosurgical referral center in Nepal was conducted. All operative cases 18 years of age or younger over a 5-year period were included. These patients were categorized by pathology and treatment. Focus areas were identified and learning areas were formulated to establish dedicated pediatric neurosurgical services. Following this, a three-month rotation at Boston Children's Hospital (BCH) was subsequently reviewed to identify key learning points relevant to impacting practice upon return to Nepal. Rollout priority and implementation strategy were developed and efficient, cost-effective treatment methods were identified.

Results

A total of 601 patients aged less than 18 years underwent neurosurgical procedure. Male to female ratio was 2:1. The youngest operated on was 2 days old. Table 1 categorizes these cases based on the different pathologies.

Table 1: Types of cases who underwent neurosurgical procedure

Types of cases	Numbers
Trauma: both head and spine injury	109 + 32=241
Tumors: infratentorial and supratentorial	121 + 89 = 210
Hydrocephalus	50
Congenital malformations: spina bifida, encephalocele, Chiari	34+ 6 + 20=60
Vascular: AVM, cavernoma	31
Others:	9
Total	601

These surgeries comprised of only 10% of total neurosurgical procedure performed at the institute. Four focus areas of pediatric neurosurgery were identified namely trauma, tumors, hydrocephalus and congenital cases. With this background work, 3 months of clinical rotation at neurosurgery unit of Boston Children's Hospital was done. The objective of this rotation was to observe key surgeries in the identified focus areas, learn about the protocols of treatment and observe how complications were managed. Besides this secondary objective was to learn about advances of equipment and technology and to see how team work and interdepartmental communication are were conducted. Operative cases observed has been tabulated in table 2.

Table 2: Types of cases observed at Boston Children's Hospital.

Types of cases	Numbers
Congenital:craniosynostosis, spinal dysrphysm, chiari I	10+ 3+ 2 =15
Hydrocephalus : ETV+CPC	5
Epilepsy : SEEG/ECOG based resection, Disconnections, ATL, VNS, DBS	15+ 6+ 4+ 1+ 2 = 28
Tumors	12
Vascular: synangiosis, cavernoma (using usg+Nav), AVM	9+ 3+ 3 =14
Deteethering of cord	10
Rizotomy: SDR, dorsal+ventral	3+ 3 =6
Total	90

A total of 90 surgeries were observed during these three months period. Besides surgery, academic activities attended included daily case discussions, seven neuroradiology meetings, twelve grand rounds four faculty teaching: and one journal club.

On return to the parent institute, these learnings were applied to create enabling environment for proper management of pediatric neurosurgical cases. Separate child friendly clinic was made with addition of pediatric neurologist in the team. Also, new sets of equipment were added according to the new skills acquired during the training. Table 3 is a list of surgeries performed over a period of 1 year after return.

Table 3 : Types of cases after returning from clinical rotation

Types of cases	Numbers
Tumors: infra tentorial + supratentorial + spine	7 + 5 + 2 =14
Hydrocephalus : ETV+ VP Shunt	3 + 4 =5
Epilepsy : ECOG based lesionectomy + temporal lobectomy	10 + 2 = 12
Vascular: cavernoma, AVM	1+1 =2
Congenital: lipomeningomyelocele + split cord + chiari	2+1+2 =5
Trauma: EDH + SDH + depressed skull fracture	1+1+3=5
Total	43

Discussion

Background and estimates of need

It is generally accepted that all children have a right to health care and failure to do so is considered as medical neglect.6 Despite this goal, even in developed countries children experience inequitable access to health care, often secondary to economic status.7 This is even more prominent in low and middle income

countries.[8] Nepal has taken instrumental steps to provide quality care to pediatric patients , made evident by the improvement in the mortality rates for children under 5 years of age.[9] With the goal of improving neurosurgical care to this population it is important to recognize that pediatricians are the key for timely referral of neurosurgical patients.[10,11]

A study done in 2018 estimated 2297 pediatric neurosurgeons in practice globally, with 85.6% operating in high-income and upper-middle-income countries.[12] In low- and lower-middle-income countries, roughly only 330 pediatric neurosurgeons care for a total child population of 1.2 billion.12 These numbers underscore the profound need for more pediatric neurosurgeons in these under-represented countries.

Approach to the problem in Nepal

Neurosurgery in Nepal has progressed in positive direction and is now on its way to develop subspecialities within neurosurgery.4 Pediatric neurosurgery is clearly identified as one of these subspecialities.[13] There are existing models in other countries that can provide some examples of models to emulate. In Haiti, Project Medishare and Haiti Healthy Kids have treated more than 1400 children with hydrocephalus and congenital disorders for a 10-year period and a neurosurgical training program is currently being developed and implemented.[12] A second example has been reported with efforts in Ethiopia.[14] However, there is no such program in Nepal. For this reason, to characterize case load and quantify need, retrospective case analysis at a tertiary level neurosurgical referral center in Nepal was conducted. Focus areas were identified and learning areas were formulated to establish dedicated pediatric neurosurgical services. Following this, a three-month rotation at Boston Children's Hospital (BCH) was subsequently reviewed to identify key learning points relevant to impacting practice upon return to Nepal. Rollout priority and implementation strategy were developed and efficient, cost-effective treatment methods were identified.

Findings and Learning Points

Surgeries for trauma, tumor, hydrocephalus and congenital conditions were most common at our home institution, mirroring results from the studies reported from Nigeria and Ethiopia.[14,15] Our case distribution was similar to the neighboring country of India.16 The cases observed at Boston Children's Hospital included all these but included a wider variety of cases not performed at the home institution. Endoscopic operations for simple craniosynostosis were performed routinely along with complete vault repair and for syndromic and complex craniosynostosis.[17] The full array of surgical approaches for epilepsy, including laser interstitial thermal therapy, was being done routinely.[18] Use of intraoperative MRI for brain tumor as well as a "sandwich" method of combined same-patient, same-anesthesia endoscopic and transcranial surgery for craniopharyngioma was observed.[19] Integrated surgical and interventional services for vascular diseases like Moya Moya, aneurysms, arteriovenous malformation, cavernous malformation and vein of Galen malformations were provided through cerebrovascular surgery and intervention center, a multidisciplinary team structured specifically for these conditions.20 Use of intraoperative neuromonitoring especially for cases like spasticity during selective and nonselective dorsal rhizotomy was routine.[21]

Key learning areas were formulated and focus was on services that can be added at the home center upon return from the training. For the surgical techniques that were already being done, it was possible to validate core methodologies while broadening options through the incorporation of new techniques. Affordable equipment like pediatric incubators, intraoperative neuromonitoring equipment and endoscopes were bought for the home institution, with the improved ability to purchase the most useful items based on new experience in the US, increasing the likelihood for a good return on investment. Team structure was modified and strengthened with the strategic addition of a pediatric neurologist. In addition, novel surgical approaches were able to be implemented after learning key points in the US, including temporal lobectomy and electroencephalogram (ECOG)-based resection for epilepsy.

Future Aims

The development of pediatric neurosurgery as a subspeciality in India started in 1989 after the International Society of Pediatric Neurosurgery's 17th annual meeting.[22] In Nepal we still have not started this as a subspeciality, with general-practice neurosurgeons continuing care for these patients. There is a need of developing this specialty with formal fellowship programs not only in Nepal but Asia and Australasia as a whole.[23] Combining training, surgical procedures with essential pre- and postoperative care and continued efforts in health system strengthening for pediatric neurosurgical care will offer the opportunity to improve outcomes of these patients - as has been seen in other countries after implementing these strategies.24

Conclusion

This work provides a current review of pediatric neurosurgery in Nepal and has highlighted the common neurosurgical treatments provided. These data will direct future areas of focus for training and resource allocation for planning a dedicated unit in Nepal. In addition, time spent at a US teaching hospital highlighted several key points that have guided to make treatment strategies upon return to Nepal which is being implemented to give the best possible outcomes to pediatric neurosurgical patients.

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