Child's Nervous System (2018) 34:797–803
https://doi.org/10.1007/s00381-018-3755-4

COVER EDITORIAL

History and current state of pediatric neurosurgery at Beijing Tiantan Hospital Neurosurgery Center

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Received: 30 January 2018 / Accepted: 7 February 2018 / Published online: 8 March 2018

Introduction

Beijing Tiantan Hospital Neurosurgery Center (BTHNC) is the most renowned and authorized institute for neurosurgical practice in China. In the early 1980s, 30 years following commitment and diligence in the practice, Dr. Chungcheng Wang, one of a key pioneering figures and co-founders of neurosurgical practice in entire China, founded Beijing Tiantan Hospital for development of neurosurgery. Since then, BTHNC has become the first largest neurosurgical practicing and research institute in the nation [1, 2].

The subdivision of pediatric neurosurgery was also initiated and co-founded by Dr. Wang in Beijing. It was the first unit for children and adolescents that has now become the largest neurosurgical center for treatment and management of all forms of pediatric neurological disorders in the entire nation. At present, this subdivision has a capacity for 40 in-patient beds with over 1000 neurosurgical operations performed with favorable outcomes annually. As a highly reputable tertiary training hospital, the department substantially ranks as the prime frontier in standards of quality and care delivery in the field of the pediatric neurosurgery all over China. It has significantly contributed to the standards and evolution of pediatric neurosurgery practice in China.

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Inception and history of Beijing Tiantan Hospital Neurosurgery Center

Neurosurgery practice in China commenced in 1950s. After attending the first training course organized by central government under the mentorship of Yicheng Zhao and former Soviet Union neurosurgical professor at Beijing Tongren Hospital in 1955, Dr. Chungcheng Wang (Fig.1a) organized one of the earliest departments that specialized in neurosurgery in China and migrated to Beijing Xuanwu Hospital (the predecessor of the department of Tiantan Hospital) for further development in 1958. Beijing Neurosurgical Institute (BNI) (Fig.2b) was founded in 1960 [1, 2].

In 1982, owing to the demand for healthcare delivery and a full-range neurosurgical services, Beijing Tiantan Hospital (Fig.2a), a non-profit public hospital, was founded. In 2004, the name BTHNC was formulated and considered as one of the principle neurosurgical centers and premier specialty institution in China.

History of pediatric unit of BTHNC

Four neurosurgical specialized subdivisions were initially established under Dr. Wang's leadership in 1960, including brain tumor, pediatrics, trauma, and spine, which were managed by four attending physician-surgeons at the time. Dr. Guangming Bai (Fig.1b) began the first pediatric neurosurgical service in China under the instruction of Dr. Wang.

In 1962, Dr. Shiqi Luo (Fig. 1c) joined the division of pediatric neurosurgery as the main assistant for Dr. Bai. He stayed to work with him for many years making tremendous contributions to the management of pediatric neurosurgical practice in the department. The culture revolution of China between 1966 and 1976 extremely destroyed the economy of China consequently resulting in the marked delay of further advancement of all specialty aspects of medical practice. Even at the time without microscopic assistance, their efforts in the

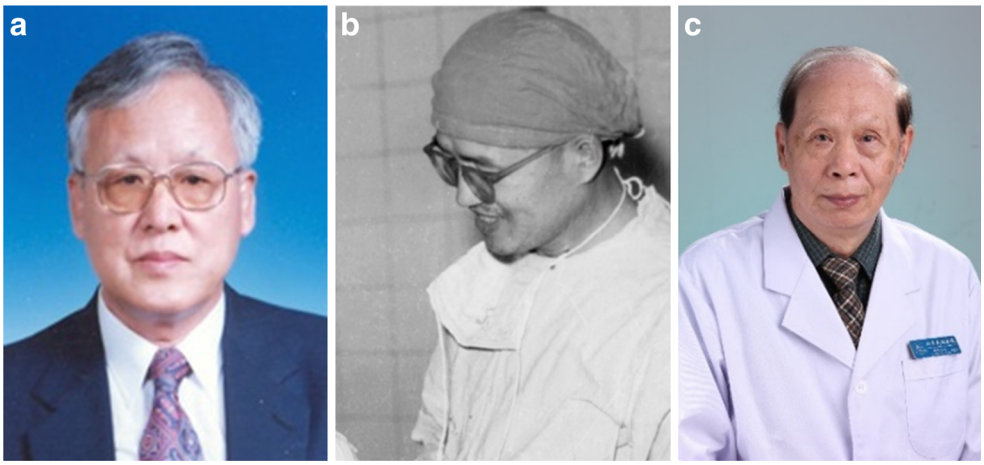

Fig. 1 Principal founders of pediatric neurosurgery in BTHNC. **a** Dr. Chungcheng Wang (icon of neurosurgery in China). **b** Dr. Guangming Bai. **c** Dr. Shiqi Luo

surgical practice were yielding satisfactory success rates for pediatric brain tumors with decreased mortality rate as lower than 2.5%. The first microsurgical resection of craniopharyngioma in China was performed successfully by Dr. Bai in 1977. Between the years 1980 and 1984, Dr. Luo published more than 20 research literature of his clinical studies regarding pediatric neurosurgery in China [3–5]. In 1984, Dr. Luo was appointed as the executive director for the department of neurosurgery while Dr. Deze Li (Fig.3a) was selected to succeed the chief position of the pediatric section of neurosurgery. They both continued to expand and enhance the quality of the professional practice and service. To date, Dr. Luo has cumulatively published more than 80 pediatric neurosurgical articles in Chinese and English journals [6–10], covering aspects of pediatric brain tumor, traumatic intracranial hematoma, and cerebral vascular disease which were particularly firstly published in China. He also published many illustrated textbooks of pediatric neurosurgery [11–14], including *Intracranial Tumor in Children* (*1992*) which won the Beijing Science and Technology Major award, *Hypothalamic Hamartoma* (*2004*), *Intracranial Germ Cell Tumors* (*2006*), and *Tumors of Neurosystem in Children* (*2006*). These contributions helped countless Chinese neurosurgeons gain much better understanding of pediatric neurosurgery in their practice. Among the main achievements in managing various forms of pediatric brain tumors, Dr. Luo performed surgical procedures and adjuvant therapies to more than 800 children with hypothalamic hamartomas and about 2000 children with intracranial germ cell tumors. He also proposed practicing guidelines for these two rare diseases of which are currently in use for the management of similar pediatric neuro-cases.

In 1995, Dr. Zhenyu Ma (Fig.3b) was appointed the chief of the division of pediatric neurosurgery. He has acquired enormous experience and insight into the management of common encountered pediatric brain tumors, including the lesions located in and around the third ventricle, optic pathway glioma, and large deep-seated lesions. His area of expertise in the practice field is often acknowledged as the first in China. In particular, he performed the first microsurgical resection of pineal region tumor with transcallosal-transseptal interforniceal approach in 1997 and has so far performed over 500 cases in a single-center [15–17]. With higher gross total resection (GTR) rate, low morbidity, and with almost zero mortality, this approach has been popularized by many neurosurgeons and introduced at international conference meetings. Additionally, he also firstly placed forward the practice of the concept of staged craniotomy with different approaches to

Fig. 2 The front gate view of current Beijing Tiantan Hospital outpatient clinic (**a**) and Beijing Neurosurgical Institute (BNI) (**b**)

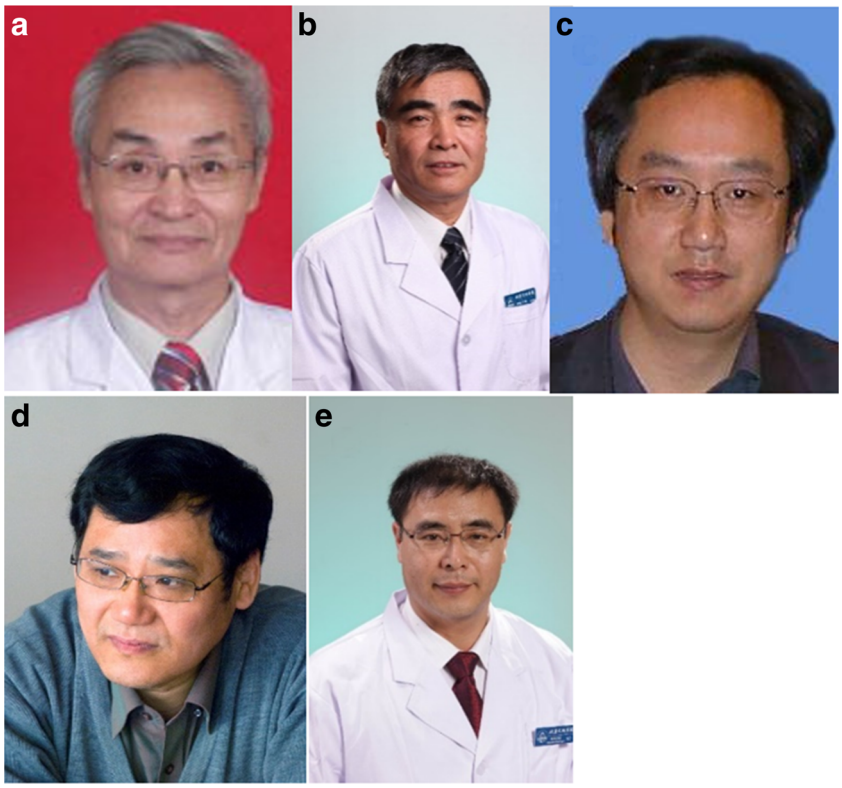

Fig. 3 The five chief pediatric neurosurgeons at BTHNC. **a** Dr. Deze Li. **b** Dr. Zhenyu Ma. **c** Dr. Yuqi Zhang. **d** Dr. Ge Jia. **e** Dr. Chunde Li (current chairman of the department of pediatric neurosurgery)

manage pediatric large deep-seated brain tumors [18]. It has been beneficial to children with optic pathway gliomas by partially removing part of the lesions followed by adjunct radiotherapy [19, 20].

After Dr. Ma's retirement, Dr. Yuqi Zhang (2009–2012) (Fig.3c) and Ge Jia (2012–2014) (Fig.3d) subsequently headed the division. To further support advancement in the practice [21–23], they co-founded pediatric committee of Chinese Congress of Neurological Surgeons (CCNS), which is affiliated to Chinese Medical Doctor Association (CMDA). The pediatric committee of CCNS organizes annual academic meetings and serves the domestic pediatric neurosurgical community.

The present program

Since 2014, Dr. Chunde Li (Fig. 3e) took the chief positions in pediatric neurosurgery and as the chair of the pediatric committee of CCNS. He focused more on the quality and efficiency of clinical practice [24–31]. Additionally, he focused on the clinical research centered around molecular pathology-based target therapy, the application of neuroendoscopy, and multimodality image-guided neurosurgery. Not only was the operative management of pediatric brain tumors significantly improved, but also congenital central nervous system disorders in infants, including procedures to treat and manage craniosynostosis [32], and spinal cord malformation have remained the emerging practical focus in this division.

With the full support from powerful BTHNC, Tiantan's pediatric neurosurgical subdivision has always played the leading role in China. Currently, this subdivision has 40 beds, 8 full-time neurosurgeons, and 2 mentors overseeing pediatric neurosurgical clinical practice and research. Children referred from all over the country benefit from the quality of care and treatment exceptionally provided by the neurosurgeons of the department. Over the past 5 years, there has been an increase in the number of admissions and improvement in the quality of care with significant decrease in mortality rate.

Neuro-oncology program is a major feature of this department and 51.8–59.1% of the treated patients have tumors in the brain or spinal cord (Fig.4). More than 500 operations are performed to manage all types of brain and spinal cord tumors in children annually with mortality rate of less than 1% (Fig.4). In 2016 alone, the total number of operations involved amounted to 1154 cases, and the number of tumors included 682 cases (Fig.4). Commonly encountered pediatric tumors of the central nervous system involved in the primary lesion location and pathology have all been managed in this department (Fig.5). For cases of craniopharyngioma, more aggressive removal procedures are currently performed with far less morbidity and mortality compared to previous years. For medulloblastoma, the combination of chemotherapy and radiotherapy after gross total or subtotal resection leading to a 5-year overall survival is about 68% [2] and a 2-year overall

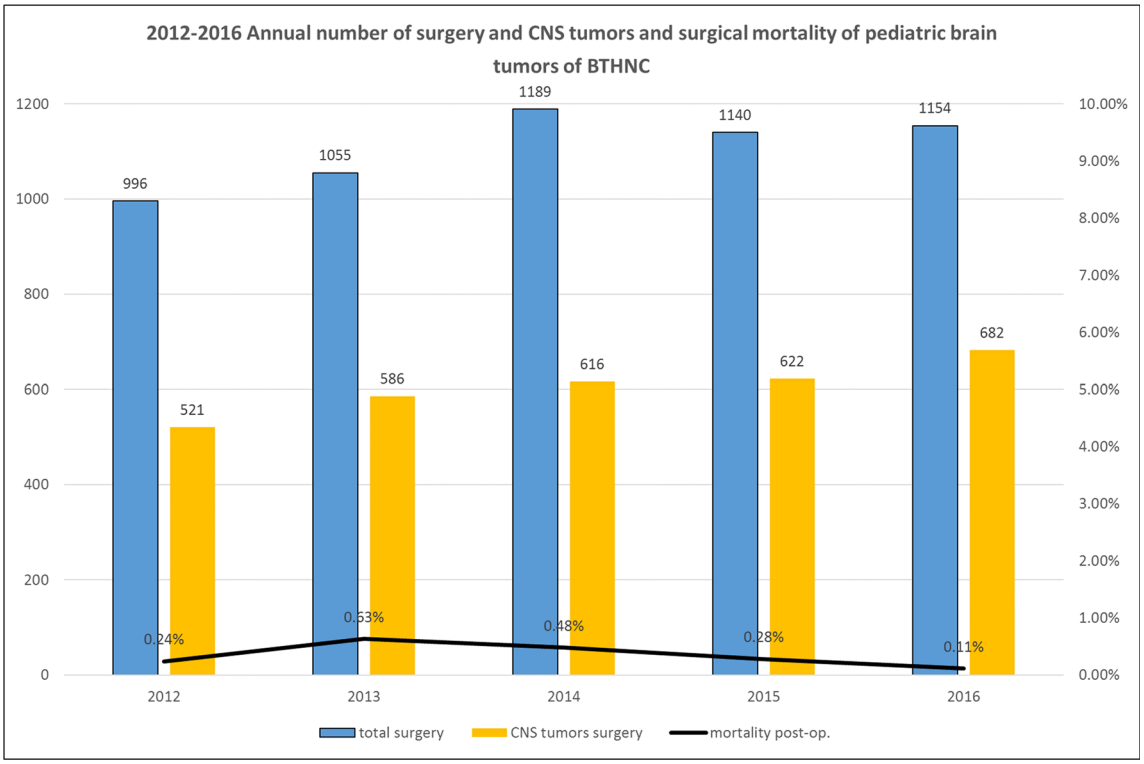

Fig. 4 Annual number of neurosurgical surgery and central nervous system tumor removal, surgical mortality of pediatric brain tumors (2012 to 2016) of the pediatric subdivision of BTHNC

survival is about 81.8 ± 5.2% [31]. Surgeries using the transcallosal-transfornixial approach have been performed for more than 500 patients with pineal region tumors with satisfactory outcomes and postoperative quality of life. This department has the largest case series of hypothalamic hamartomas [24, 27, 28], intracranial germ cell tumors, and optic pathway gliomas [20] in China. Highly advanced equipment, including high-quality-controlled operating theaters, neuroendoscopy, neuronavigation, intraoperative ultrasonography, and electrophysiological monitoring are employed to support the pediatric neurosurgeons to achieve the operational excellence.

Research program

The pediatric brain tumor program has been focusing on the following areas: risk stratification of childhood medulloblastoma in molecular classification [31], protection for pituitary stalk in craniopharyngioma surgery, multi-modality therapy

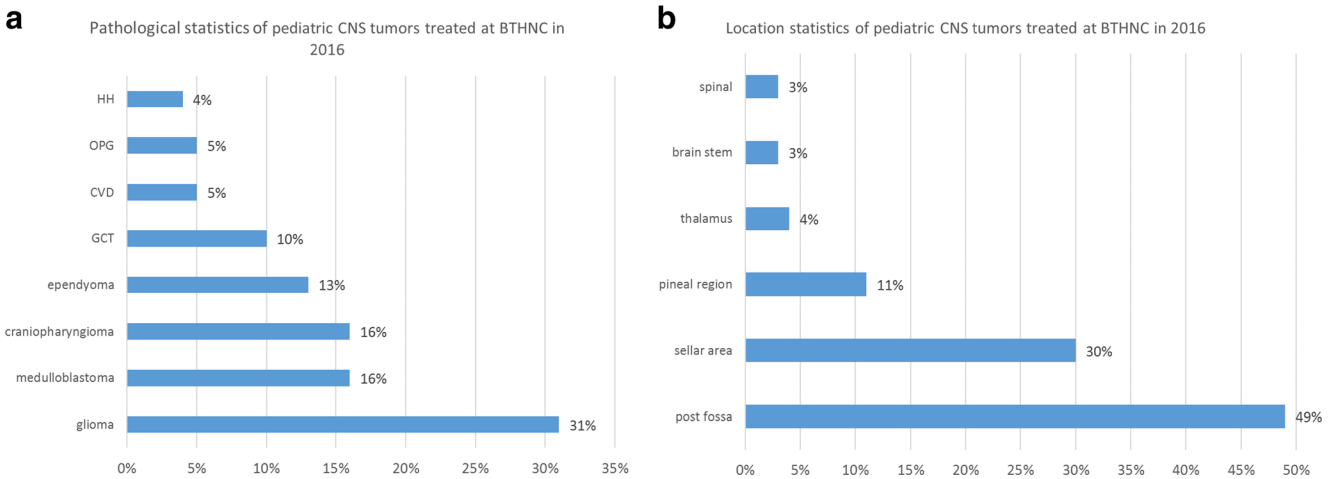

Fig. 5 Primary pathological (a) and location (b) statistics of central nervous system tumors treated at pediatric neurosurgery of BTHNC (2016).HH, hypothalamus hamartoma; OPG, optic path glioma; CVD, cerebral vascular disease

Fig. 6 Cover figure. Computer graphic of the brand-new Beijing Tiantan Hospital building (**a**) and its outpatient clinic now under construction (**b**), which opened at the end of 2017. New facilities have replaced the old wards at a new address

for optic pathway gliomas [20] and germ cell tumors [17, 23], progress of basic research for craniopharyngioma [33], ependymoma, and hypothalamic hamartoma [24, 27, 28]. In addition, numerous publications in peer-reviewed journals have also been published [34–38]. In 2016, BTHNC became one of the fifteen primary member institutions of the Children's Brain Tumor Tissue Consortium (CBTTC), which is a collaborative, multi-institutional research program dedicated to the study and treatment of childhood brain tumors.

Continuing education

Pediatric neurosurgery is encountered as a challenging specialty for every neurosurgeon. Beijing Tiantan Hospital is an affiliated hospital and the most important neurosurgical training center for pediatric neurosurgery in China [39]. Annually, national training programs are held in this unit for pediatric neurosurgeons all over China. Owing to the rich clinic resources and high-quality training programs, only several spots become available to eligible candidates to obtain rotational opportunities in its highly competitive residency training program annually. Residents get to rotate through all neurosurgical subspecialties including pediatric unit and get to complete their residency training after completing the structured surgical clinical program requirement. Additionally, this institution attracts the most competent candidates from all over country for clinical fellowship training program annually. Majority of these trainees aim for further development of pediatric neurosurgery in China. Since 1990s, pediatric neurosurgery has dramatically developed mostly in major cities in China, including Shanghai, Nanjing, Guangzhou, and gradually around in China.

It has also been open to welcome international visitors. There is an increasing demand in academic exchange and cooperation between BTHNC and international community, including International Society for Pediatric Neurosurgery (ISPN), a platform where numerous pediatric neurosurgeons interact.

The future

A brand-new established hospital (Fig.6) in Beijing will be completed at the end of 2017 and there would be remarkable expansion of BTHNC including the pediatric subdivision. The in-patient capacity is planned to increase with the number of pediatric beds in the department reaching over 50. Furthermore, a new independent pediatric neurosurgical intensive care unit will be made available. At that time, world-class equipment and high-quality clinical service will be established. The future goal of the subdivision of pediatric Neurosurgery at BTHNC is to continue providing a cutting-edge clinical care to children with neurosurgical diseases and set its platform as one of the outstanding units in the world.

Acknowledgements The authors would like to thank Ms. Dan Wang for providing most of photographs in this article.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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