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Epidemiology of epilepsy surgery in India

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Abstract:

Epilepsy surgery in India has seen remarkable advances over the last twenty years. Presently 39 centers are undertaking epilepsy surgeries in India on a regular basis. Out of these, 18 centers have become operational in the last five years. Many of them are well equipped with high end technologies and have expertise to undertake all kinds of epilepsy surgeries. Till July 31st, 2016, approximately 7143 epilepsy surgeries have been performed in India. Presently, 734 epilepsy surgeries are carried out in India every year representing an increase of approximately 58% over the last three and a half years as compared to the previous years. The reported postoperative outcomes from all these centers are comparable to those reported from the well-established centers in high income countries. Still, only 2 in 1000 eligible patients in India undergo epilepsy surgery, because of which, the enormous surgical treatment gap continues to persist. To tackle this, by the year 2020, India should have at least 60 state-level epilepsy surgery centers (with each undertaking at least 50 surgeries per year) and 6 national centers of excellence. Here, we discuss the current prevalence and practice of epilepsy surgery in India and suggest pragmatic steps and solutions to make epilepsy surgery affordable and widely available. The steps also include a framework for the development of a national epilepsy surgery program.

Key Words:

Epidemiology, epilepsy surgery, national epilepsy surgery program

Key Message:

An urgent need for establishing new epilepsy surgery centers in all the states of India exists. This may be implemented by reproducing successful and pragmatic epilepsy surgery models and developing a national epilepsy surgery program. This will help in achieving the goal of providing affordable and quality surgical care to all the deserving patients suffering from epilepsy in the country.

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Epilepsy surgery has become a well-established treatment modality for selected patients with drug-resistant epilepsy over the last 30 years. Still, epilepsy surgery remains largely underutilized in developing countries. With a medical treatment gap as large as 50-60% in majority of the low and middle income countries (LAMIC), epilepsy surgery remains in the nascent stage in these countries. A 2006 survey conducted by the World Health Organization, International League Against Epilepsy, and International Bureau of Epilepsy found that epilepsy surgery was available in only 13% of LAMIC as compared to 66% of high-income countries.^[1] Until fifteen years ago, there were only 2 or 3 epilepsy surgery centers in India catering to the population of one billion. Since then, the good results obtained by these centers along with the improved awareness of epilepsy surgery in physicians and lay public have encouraged many young neurologists and neurosurgeons to get trained in epilepsy surgery and start new epilepsy

surgery centers. A survey in 2015 had shown that there were 18 epilepsy surgery centers undertaking regular epilepsy surgeries in India.^[2] Since then, many more epilepsy surgery centers have become operational. In this article, we trace the evolution of epilepsy surgery in India, discuss the current prevalence and practice of epilepsy surgery in our country and try to suggest the future steps for making epilepsy surgery affordable and more widely available even in the remote corners of the country including the framework for a National Epilepsy Surgery Program.

Epilepsy Surgery in Ancient India

Trephination, as a procedure to cure epileptic seizures and mental disorders, was widely prevalent in ancient societies of Europe, America, Africa and Asia. This ancient practice is believed to have begun approximately 4,000 to 5,000 years ago. In India, evidence of trephination has been found in skulls recovered from many Harappan sites such as Lothal and Kalibangan in Western

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India and Maski (Karnataka) in south India.^[3] However, the best evidence of multiple trephinations has been obtained from a neolithic skull recovered from Burzahom, located in present day Kashmir valley.^[3,4] This skull of a female subject, dating back to 4,000 to 4,300 years, provides evidence that 11 attempts at trephination were made with six completed circular or oval burr holes at the left parietal bone.^[3,4] The hypertrophy of left calvarium, in all likelihood, represented an underlying, long standing cortical atrophy. Although one cannot be sure of the patient's symptoms or the indications for trephination, evidence suggests that the patient might have had epilepsy. However, there is no mention of surgery for epilepsy in the ancient Ayurveda book "*Sushruta Samhita*" written by sage Sushruta, about 2,000 years ago.^[5]

Epilepsy Surgery in Modern India

The development of epilepsy surgery in modern India can be divided into four distinct phases.

Phase 1 (1950 -1975): The initiation

The first department of neurosurgery in India was established by Dr. Jacob Chandy at the Christian Medical College (CMC), Vellore in 1949. He was trained at Montreal Neurological Institute, Canada under Dr. Wilder Penfield and Dr. Theodor Rasmussen, both pioneers of modern epilepsy surgery. His dream of starting the first epilepsy surgery program at CMC got a boost when Dr. Baldev Singh, who was trained at the Institute of Neurology, Queen Square, London, joined CMC as a neurologist. They together as a team performed the first epilepsy surgery of India on 25th August, 1952 in the form of left hemispherectomy on a patient with right hemiplegia who hailed from Thrichur (Trissur), Kerala.^[4,6] Subsequently, the Institute of Neurology at Madras (Chennai) was the second center to start epilepsy surgery in India in 1954. It was established by the eminent neurosurgeon, Dr. B. Ramamurthy in collaboration with the neurologist, Dr. T. S. Narasimhan.^[4,6] Consequently, several hundred surgeries were performed at these centers until the early 1970s.^[7-11] Localization was based on the clinical history and the physical examination supplemented by scalp electroencephalography (EEG), electrocorticography and the available radiological investigations such as plain skull radiographs, carotid angiogram and pneumoencephalogram. However, as expected, localization was often inaccurate and this resulted in less than optimal outcomes. In 1999, CMC Vellore published their experience of epilepsy surgery in 141 patients over 40 years.^[12] This included 102 (73%) patients with temporal resections, 23 (16%) patients with extratemporal resections, and 16 (11%) with multilobar resections. Overall, seizure freedom or near seizure freedom was achieved in 53% patients while another 20% patients had worthwhile improvement. During this period, the Institute of Neurology at Madras also performed stereotactic lesions in the amygdalo-hippocampal complex for temporal lobe epilepsy and in the central nucleus of thalamus for generalized seizures.^[10,11]

Phase II (1975-1995): The decline

Due to the less-than-optimal results coupled with the availability of many new antiepileptic drugs, epilepsy surgery fell into disrepute in India from the mid 1970s, as was the observation elsewhere in the world. The problem was further compounded by the retirements of Dr. Chandy and Dr. Ramamurthy and the

disenchantment in lay people for epilepsy surgery, which they perceived as psychosurgery. Due to all these reasons, epilepsy surgery came to nearly a stand-still in India, as was observed elsewhere in the world from 1975-1995.

Phase III (1995-2000): The resurgence

With the availability of computed tomographic (CT) scan and magnetic resonance imaging (MRI) which helped in a much better visualization and localization of epileptogenic lesions, there was a renewed interest in epilepsy surgery all over the world. India was also not left behind and two centers became pioneers in starting epilepsy surgery in India.^[4,6] The first center was R. Madhavan Nayar Center (RMNC) for Comprehensive Epilepsy Care at Sree Chitra Tirunal Institute of Medical Sciences and Technology, Trivandrum, Kerala. The center was established by the senior author (KR) of this article who returned from USA after getting trained at the epilepsy program, Mayo Clinic, Rochester, Minnesota, USA. He formulated a team of dedicated neurologists, neurosurgeons, neuroradiologists, neuropsychologists, psychiatrists, speech therapists, occupational therapists and neurotechnologists. The initial surgeries at RMNC were performed by Dr. Malla Bhaskara Rao, the young neurosurgeon who was trained initially under Dr. B. Ramamurthy and subsequently at various other centers abroad. The first surgery at RMNC was performed on March 20, 1995 in the form of left anterior temporal lobectomy with amygdalo-hippocampectomy on a 25-year old male patient with left mesial temporal sclerosis.^[4] The second center was established at the All India Institute of Medical Sciences (AIIMS), New Delhi by a team consisting of the neurosurgeon Dr. V. P. Singh, neurologist Dr. Satish Jain and clinical electrophysiologist Dr. Manvir Bhatia. They performed their first epilepsy surgery in April, 1995 on a one-and-a-half year old girl child with left temporal meningio-angiomas.^[6,13] Both centers initially faced the problem of unavailability of high-end equipment and skepticism among the colleagues in neurosciences. However, all these initial problems were overcome by innovative ideas, perseverance, dedication, sincerity and hard work. Since 1995, both these centers have remained in the forefront of epilepsy surgery in India and till date a combined total of 3000 epilepsy surgeries have been performed at these two centers.^[2]

Phase IV (2000-2015): Consolidation and proliferation

Due to the good results obtained by these centers along with the increased awareness of epilepsy surgery among the neurologists, there was a renewed interest in starting epilepsy surgery programs in India. The RMNC, in particular, was instrumental in encouraging this trend by providing training to many young neurologists. Till date, more than 25 neurologists have been trained in advanced epilepsy and epilepsy surgery at RMNC alone.^[14] Subsequently, postdoctoral training programs in epilepsy were also started at other national institutes such as AIIMS, National Institute of Mental Health and Neurological Sciences (NIMHANS), Bengaluru, Govind Ballabh Pant Institute of Postgraduate Medical Education and Research, New Delhi, and Amrita Institute of Medical Sciences (AIMS), Kochi, Kerala. This led to the establishment of many new epilepsy surgery centers all over the country, and at present, 38 centers are regularly undertaking epilepsy surgeries in India [Figure 1].



Figure 1: Map of India depicting the geographic distribution of epilepsy surgery centers across the country

As a part of this review, we formed a list of all the epilepsy surgery centers in the country and contacted them for information regarding the total number of epilepsy surgeries carried out at each center until 31st July, 2016. This data is provided in Table 1. Presently, 39 centers are undertaking epilepsy surgery in India, of which 18 centers have become operational in the last five years. Regarding the number of surgeries, 14 centers have undertaken more than 100 surgeries each, while two centers have undertaken more than 1000 surgeries each. Of the 39 centers, 27 (69%) are located in the private sector. With regard to the number of surgeries, four out of the top five centers are operational in the government sector. The states of Maharashtra and Karnataka have the maximum numbers of centers, eight in each state. However, the distribution of these centers is skewed. Almost all the centers are located in and around major cities and 19 centers are located within five major metropolitan cities. On the other hand, states like West Bengal, Bihar, Jharkhand, Chhattisgarh, Rajasthan, Himachal Pradesh, Uttarakhand and a major part of the north-east region of the country have no centers. Two large states namely Madhya Pradesh and Uttar Pradesh have one and two centers each, respectively, which have been started only recently.

Overall, approximately 7143 epilepsy surgeries have been carried out in India till July 31st, 2016. The last survey, which included 18 centers, specified a figure of 4252 surgeries till December, 2012. Thus, the present figure of 7143 surgeries indicates that 2891 more surgeries have been carried out over the last three-and-a-half years. However, the present survey included some of the centers which were operational before 2012 and were not included in the previous survey. Excluding the number of epilepsy surgeries from these centers which

were done before December 2012, we can roughly estimate that 2570 more surgeries have been carried out in the last three-and-a-half year representing an incidence of 734 epilepsy surgeries per year. This represents a 58% increase in the annual rate of epilepsy surgery over the last three-and-a-half years as compared to the previous years. This trend is in contrast to the one seen in the western countries such as the United States of America (USA), United Kingdom (UK) and Sweden where the number of epilepsy surgeries is declining in the recent years.^[15-17] This is largely related to the presently existing large surgical treatment gap in India resulting in the presence of a large number of eligible patients for surgery, while this gap has already been reduced to a minimal number in the western countries.

We also obtained information about the different types of epilepsy surgeries being carried out at three major centers, namely AIIMS, New Delhi, Krishna Institute of Medical Sciences (KIMS), Hyderabad and Amrita Institute of Medical Sciences (AIMS), Kochi, Kerala. While half of the surgeries at AIIMS have been temporal surgeries [Figure 2a], the proportion of temporal surgeries at KIMS is about 67% [Figure 2b]. Overall, AIIMS has carried out more callosotomies and hemispherotomies as compared to the other centers. Compared to other two centers, AIMS, Kochi has undertaken proportionally more extratemporal surgeries [Figure 2c], which may be related to expertise and technologies (such as stereo-EEG [SEEG] and robot- and image-guided SEEG electrode placement planning and surgery) available at this center, which has facilitated the selection of more and more MRI-negative patients for epilepsy surgery.

Over the years, there have been many advances in the process of presurgical evaluation and epilepsy surgery in India. Due to the lack of advanced technologies in the early years, both RMNC and AIIMS confined their patient selection to noninvasive techniques and restricted patient selection to those with well-defined, surgically remediable syndromes.^[6,18] With more experience and the availability of newer technologies, more complex cases were selected and operated. Intraoperative electrocorticography and intracranial monitoring were started at RMNC in 2002. Presently, most of the state-of-the-art technologies available in the western countries are available in major centers of India. A recent survey involving 18 centers has shown that 16 centers have been regularly using fluoro-deoxy glucose-positron emission tomography (PET) and ictal single photon emission computed tomography (SPECT), 14 centers have been using functional MRI, and 11 centers have been using diffusion tensor imaging. Similarly, 14 centers have routinely performed an intraoperative electrocorticography, 13 centers had undertaken an intracranial EEG monitoring and seven had undertaken an extra-operative cortical stimulation and mapping.^[2] Two centers, namely AIIMS and NIMHANS, are routinely using magnetoencephalography (MEG) for the presurgical evaluation of epilepsy. This has led to an increase in the number of complex surgeries being performed in India. In the two major centers, namely RMNC and AIIMS, there has been a 2.7 increase in the number of temporal surgeries, while there has been a 7.1 fold increase in the number of extratemporal surgeries in the period between 2007-2012, as compared to period between 1995-2000, indicating that increasingly more complex cases are being selected and

Table 1: The number of epilepsy surgeries carried out by 38 epilepsy surgery centers operational in India on July 31, 2016

Name of center/institution/location	Year of commencement	No. of surgeries until July 31, 2016
R. Madhavan Nayar Center for Comprehensive Epilepsy Care, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, Kerala	1995	1650 [§]
All India Institute of Medical Sciences, New Delhi	1995	1325
Krishna Institute of Medical Sciences, Hyderabad	2005	752
National Institute of Mental Health and Neurosciences, Bengaluru, Karnataka	1997	550
King Edward Memorial Hospital, Mumbai, Maharashtra	2001	502
CARE Hospital, Hyderabad	2001	356
Postgraduate Institute of Medical Education and Research, Chandigarh	2003	200
P.D. Hinduja Hospital and Medical Research Center, Mumbai, Maharashtra	1998	198
Amrita Institute of Medical Sciences, Kochi, Kerala	2004	197
Nizam Institute of Medical Sciences, Hyderabad	2010	172
Vikram Hospital, Bengaluru, Karnataka	2010	150 [§]
Christian Medical College, Vellore, Tamil Nadu	2004	141
G.B. Pant Institute of Postgraduate Medical Education and Research, New Delhi	2008	120
Fortis Hospital, Chennai, Tamil Nadu	2010	120
Jaslok Hospital, Mumbai, Maharashtra	2001	110
Narayana Hrudayalaya, Bengaluru, Karnataka	2006	90
Kokilaben Dhirubhai Ambani Hospital, Mumbai, Maharashtra	2009	80
Medanta. The Medicity, Gurgaon, Haryana	2010	76
KG Hospital, Coimbatore, Tamil Nadu	2011	63
Dayanand Medical College, Ludhiana, Punjab	2003	28
Deenanath Mangeshkar Hospital, Pune, Maharashtra	2015	32
Central India Institute of Medical sciences, Nagpur, Maharashtra	2013	30
Smt. B. K. Shah Medical Institute and Research Center, Vadodara, Gujarat	2015	25
Sakra World Hospital, Bengaluru, Karnataka	2014	24
Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow	2014	19
United Cigma Hospital, Aurangabad, Maharashtra	2014	18
Sagar hospitals, Bengaluru, Karnataka	2015	17
Manipal Hospital, Bengaluru, Karnataka	2013	14
St. John's Medical College and Hospital, Bengaluru, Karnataka	2010	12
Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry	2015	12
Sahyadri Hospital, Nashik, Maharashtra	2015	12
Fortis Hospital, Noida, Uttar Pradesh	2012	11
V.S. Hospital and Hope Neurocare Center, Ahmedabad, Gujarat	2014	8
Kasturba Medical College, Manipal, Karnataka	2015	8
Sir Ganga Ram Hospital, New Delhi	2010	3
GNRC Hospital, Guwahati, Assam	2014	3
King George's Medical University, Lucknow, Uttar Pradesh	2015	3
Medanta Hospital, Indore, Madhya Pradesh	2016	3
Government Medical College, Surat, Gujarat	2016	2

[§]These figures are approximate because the exact numbers were not available

operated.^[2] This has also led to new advances in epilepsy surgery such as the endoscopic guided callosotomy and hemispherotomy which have been recently described from AIIMS.^[19,20] The AIMS, Kochi has been a pioneering institute in starting stereo-EEG in India, and since then, a few more centers have also started undertaking stereo-EEG regularly. Till date, 41 stereo-EEG implantations have been carried out at AIMS alone. Similarly, AIIMS, New Delhi has also started robotic implantation of stereo-EEG and till date 35 such implantations have been carried out at this center. A Center of Excellence for Epilepsy has also been established at National Brain Research Center (NBRC), Manesar, Gurugram and AIIMS, New Delhi since 2010 with an aim to undertake molecular and translational research in epilepsy.

Outcome of Epilepsy Surgery in India

For the outcome data, we searched PubMed for the publications reporting the outcome of epilepsy surgery from India. We excluded articles which primarily focused on other aspects of epilepsy surgery such as quality of life and memory outcomes. Similarly, we tried to exclude the duplicate publications from individual centers. This data is provided in Table 2. We found 23 articles describing the outcome in 2109 patients.^[12,19-40] Almost all these reported data have come from five major centers indicating a robust system of record keeping and patient follow-up at these centers. This included all types of different surgeries including temporal and extratemporal resections, callosotomy, hemispherotomy and surgeries for different

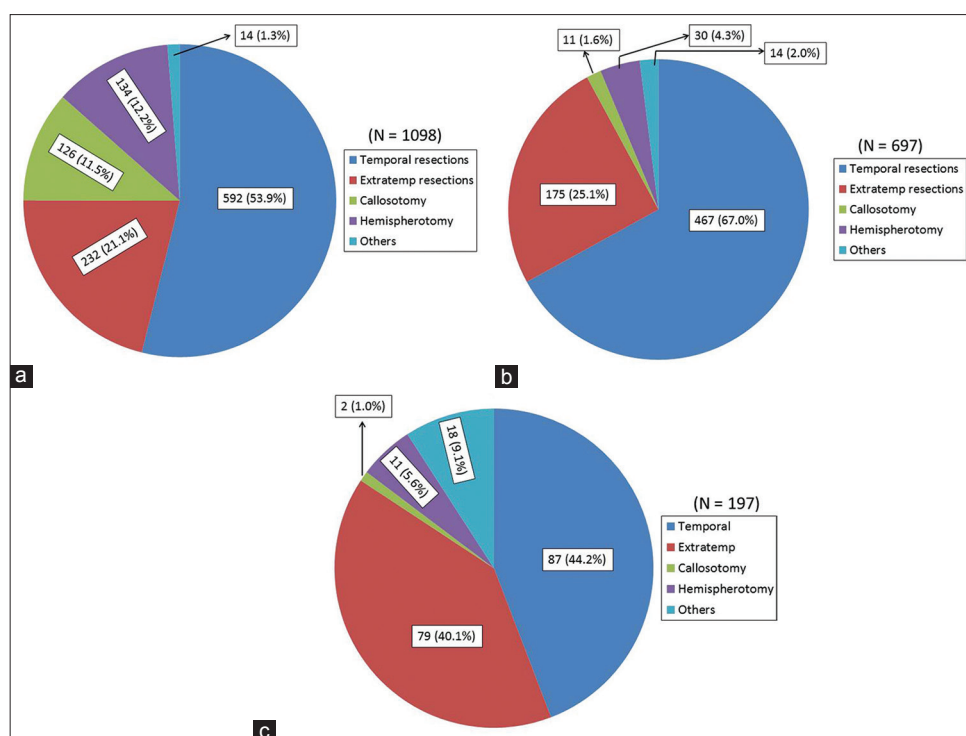


Figure 2: Comparison of the types of epilepsy surgery undertaken at three centers in India: (a) All India Institute of Medical Sciences, New Delhi; (b) Krishna Institute of Medical Sciences, Hyderabad, Telangana; and, (c) Amrita Institute of Medical Sciences, Kochi, Kerala. (Extratemp – Extratemporal)

pathologies and in different age groups. The overall outcome reported in these studies is very much similar to the outcomes described from developed countries.

A Model of Epilepsy Surgery in India

Epilepsy surgery programs in India and other LAMICs cannot blindly follow the patterns and protocols of epilepsy surgery programs in the western world. Many important issues need to be considered while establishing and sustaining epilepsy surgery programs in our country. Based upon our experience of establishing and sustaining RMNC for 17 years, we highlight some of the important aspects of establishing epilepsy surgery programs in our country.^[14] Firstly, the majority of the epilepsy surgery centers in India will not have high-end technologies and expertise available in the high income countries and the success of epilepsy surgery programs in India will depend upon the ability of the team to select ideal surgical candidates using locally available technology and expertise without compromising on patient safety. Secondly, in India where patients and their caregivers bear the cost of medical care, majority of the patients will not be able to afford the expensive investigations which may be required during the process of presurgical evaluation. Thirdly, because of the large surgical treatment gap, the number of patients waiting for presurgical evaluation and epilepsy surgery, especially at the established centers will far exceed the capacity of the given center, which results in long waiting lists. Fourthly, there are very few trained professionals to initiate and maintain the epilepsy surgery programs in India. Similarly, many eligible patients will not agree to be subjected to epilepsy surgery despite its obvious advantages because of illiteracy, ignorance, wrongly perceived risks, costs and complications of epilepsy surgery.

For overcoming these problems, certain pragmatic solutions can be suggested. Firstly, the epilepsy surgery centers in India should follow a step-wise approach for patient selection. The upcoming centers should initially restrict their patient selection to those with mesial temporal lobe epilepsy associated with hippocampal sclerosis (MTLE-HS) and circumscribed potentially epileptogenic lesions in whom the epileptogenic zone can be unquestionably localized by using locally available relatively inexpensive and noninvasive technologies, and in whom excellent postoperative outcome can be guaranteed.^[14,18] Once the center becomes experienced, then more difficult cases requiring second and third stage investigations such as PET, SPECT, and intracranial monitoring can be selected. Secondly, Indian epilepsy surgery centers will also have to evolve a cost-effective presurgical evaluation strategy by restricting the number of investigations to the minimum required. We have shown that the judicious use of sphenoidal electrodes during video-EEG (VEEG) recording in patients with suspected MTLE can obviate the need for an invasive EEG monitoring in nearly one in five of them.^[41] Similarly, patients who require an ictal SPECT can be carefully selected to optimize the utilization and yield of this test.^[42] The costs can also be reduced by outsourcing some of the expertise and investigations. Thus, psychologists, psychiatrists and occupational therapists can be hired on a part-time basis rather than as full-time consultants. The treatment can be subsidized for the less privileged patients, especially in the government sectors. Thus, patients who can afford can be charged the full cost of the evaluation and surgery, while the poorer patients can be charged a lesser amount. In this regard, the insurance schemes by many state governments such as “Arogyashree” in Andhra Pradesh and “Mukhyamantri Amrutum Yojna” in Gujarat, where the state bears the full cost of surgery on a nominal insurance premium, have greatly helped in extending the benefits of epilepsy surgery

Table 2: Published outcome data of different types of epilepsy surgeries from India

Reference	Center	Year	Type of surgery	No. of patients	Follow-up duration: Minimum (mean)/range	Outcome*
Rathore <i>et al.</i> ^[21]	SCTIMST	2011	Temporal	310	5 years (8±2 years)	82% SF
Savitr Sastri <i>et al.</i> ^[22]	NIMHANS	2014	MTS	87	5 years	77.2%
Ravat <i>et al.</i> ^[23]	KEMH	2015	Bilateral MTS	35	1 year	74%
Shukla <i>et al.</i> ^[24]	AIIMS	2003	Extratemporal	25	(16.8 months)	72%
Menon <i>et al.</i> ^[25]	SCTIMST	2012	Extratemporal	106	2 years (4.6 years)	59% SF
Daniel <i>et al.</i> ^[12]	CMC	1999	T + ET	80	1 year (10 years)	45%
Dhiman <i>et al.</i> ^[26]	NIMHANS	2013	Non-MTS lesions (T + ET)	68	(2.9±2.1 years)	63.2%
Chandra <i>et al.</i> ^[27]	AIIMS	2014	T + ET	T=60; ET=63	5 years	T=62% ET=52%
Panigrahi <i>et al.</i> ^[28]	KIMS	2016	T + ET	T=467 ET=175	1 year	T=85.7% ET=65.2 (Engel class I + IIA)
Ravat <i>et al.</i> ^[29]	KEMH	2016	T + ET	51	1 year	84.3%
Chandra <i>et al.</i> ^[20,30]	AIIMS	2008, Open and 2016 endoscopic hemispherotomy		24	3-50 months	91.6%
Panigrahi <i>et al.</i> ^[31]	KIMS	2015	Hemispherotomy	21	2 years	90.5% SF
Rathore <i>et al.</i> ^[32]	SCTIMST	2007	Callosotomy	17	1 year (4.7 years)	65%
Chandra <i>et al.</i> ^[19]	AIIMS	2016	Endoscopic callosotomy	16	16-27 months	100%
Dagar <i>et al.</i> ^[33]	AIIMS	2011	Pediatric	118	1 year	79.5%
Jayalakshmi <i>et al.</i> ^[34]	KIMS	2011	Pediatric	87	1 year	64% SF
Tripathi <i>et al.</i> ^[35]	AIIMS	2008	Cortical dysplasia	57	3 years	51%
Chandra <i>et al.</i> ^[36]	AIIMS	2010	Post-infectious	28	(14.2 months)	60.7%
Jayalakshmi <i>et al.</i> ^[37]	KIMS	2014	Hypothalamic hamartoma	6	3 years	50%
Ravat <i>et al.</i> ^[38]	KEMH	2015	Temporal tumors	34	(62 months)	85.29%
Radhakrishnan <i>et al.</i> ^[39]	SCTIMST	2016	Tumors	105	3 years (7.5 years)	74.2% SF
Radhakrishnan <i>et al.</i> ^[40]	SCTIMST	2016	Cortical dysplasia	69	5 years	67% SF

AIIMS = All India Institute of Medical Sciences; CMC = Christian Medical College; KEMH = King Edward Memorial Hospital; NIMHANS = National Institute of Mental Health and Neurosciences; SCTIMST = Sree Chitra Tirunal Institute for Medical Sciences and Technology; T = Temporal; ET = Extratemporal; MTS = Mesial temporal sclerosis; SF = Seizure free; *Outcome represents Engel class I outcome unless specified; For callosotomy, outcome represents proportion of patients free of drop attacks

to less privileged patients. Thirdly, to overcome the long waiting lists, patients who are likely to be surgical candidates should be judiciously selected for presurgical evaluation from a large pool of patients with refractory epilepsy. Hence, all eligible patients should be evaluated by a trained epileptologist in detail before contemplating VEEG and further presurgical evaluation. Fourthly, established epilepsy surgery centers should develop training programs for the young neurologists and neurosurgeons, and should undertake efforts to spread the awareness of epilepsy surgery among the local physicians and lay public.

Development of National Epilepsy Surgery Network

In spite of the development of many new epilepsy surgery centers in recent years, less than 800 epilepsy surgeries are performed annually in India in 2016, compared to 2,500 in China in 2012. Even these epilepsy surgery centers in India are located in urban and few geographically restricted areas rather than being spread all over the country. With a prevalence rate of 5 per 1,000 person-years and an incidence rate of 50 per 100,000 person-years, it is estimated that at any given time, India has at least 5 million people with active epilepsy, to which nearly 500,000 people are added annually.^[43] Considering that 25% of these patients have drug-resistant epilepsy and half of

them are potential candidates for epilepsy surgery, it can be estimated that there are at least 500,000 candidates for epilepsy surgery in India at any given time point. Thus, only 2 in 1000 eligible patients undergo epilepsy surgery in India. This has resulted in a growing pool of patients with drug-resistant epilepsy, which account for 80% of the health care costs for epilepsy. It indicates the continuing need for establishment of many new epilepsy surgery centers in the remote corners of the country.

With the limited resources available, it is neither possible nor desirable that all the epilepsy centers in India should be equipped with high levels of technologies and expertise. Hence an epilepsy care model will have to be developed where patients with easy-to-control epilepsies or those who can be offered surgery with minimal investigations can be managed at peripheral centers while patients requiring advanced care can be referred and managed at national epilepsy surgery centers, which are equipped with all types of technologies and expertise.^[14] In our opinion, by the year 2020, India should aim to have 2-3 major epilepsy centers per state (about 60 for the whole country) and 6 national epilepsy surgery centers of excellence, which can undertake complex presurgical evaluations and surgeries and train medical and paramedical

personnel required to initiate and sustain state-level epilepsy surgery centers all over the country [Figure 3]. To cater to the large pool of patients, each state epilepsy surgery center should strive to undertake at least 50 surgeries per year.

India is a union of twenty nine states and seven union territories, with the populations in them ranging from 1 to 200 million, which are further subdivided into different districts. For taking epilepsy care to grass root levels, each district can have an epilepsy care center managed by trained primary care physicians who can diagnose epilepsy and initiate treatment and can also detect drug-resistance early in the course of the disease. These epilepsy care centers should be connected to state-level comprehensive care centers where patients with difficult-to-control epilepsy can be evaluated and those who can be selected with noninvasive investigations can be offered epilepsy surgery. This should be followed by a third tier of advanced referral centers at regional or national levels where patients who require advanced presurgical evaluation and epilepsy surgery can be referred and managed. In this regard, well established centers should take the initiative to encourage new epilepsy surgery centers to develop by helping them in the initial stages. All the epilepsy surgery centers should also learn from each other by frequent discussions and meetings. National Epilepsy Surgery Support Activity Network (NESSAN) is a step in this direction to promote and support new epilepsy surgery centers.^[44]

Conclusions

Recent years have witnessed the rapid expansion of epilepsy surgery activity in India with the establishment of many new epilepsy surgery centers and further consolidation of established centers. Presently, many centers in India are equipped with all the high end technologies and have produced surgical results comparable with any other center in the world. Still, less than 800 epilepsy surgeries are undertaken in India annually which is grossly insufficient to tackle the enormous pool of eligible patients. There is an urgent need for establishing new epilepsy surgery centers in all the states of India by reproducing successful pragmatic epilepsy surgery models and developing a national epilepsy surgery program so as to provide affordable and quality surgical care to all the deserving patients.

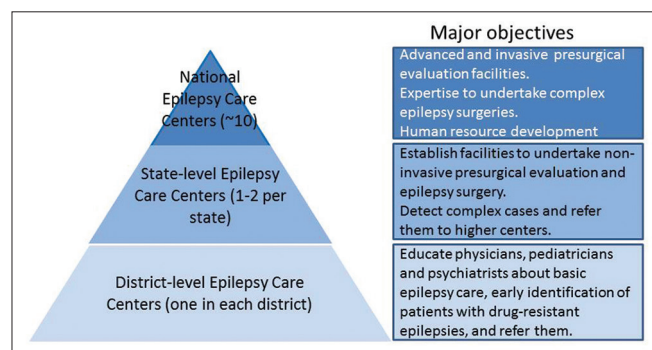


Figure 3: Proposal for a National Epilepsy Surgery Program depicting a cost-effective pyramidal model from community to the national level with ascending sophistication of care to decreasing number of patients

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Conflicts of interest

There are no conflicts of interest.

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