

# NEUROSURGERY IN LAST TWO DECADES

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## **Introduction**

Sixty years have passed since integrated modern neurosurgery initiated in India by Dr. Jacob Chandy at Vellore followed by Dr. B. Rammaurthia at Chennai in 1950 and Dr. Ram G. Ginde in Mumbai, in the year 1951. Previous review in 1970 for two decade by Dr. Ginde and second review from 1970-1989 by Dr. Kak has enhanced our knowledge on the progress that took place in a period of 40 years.

The review of Dr. Ginde, highlights the formative Phase I, a few centres with the kind of struggle to start and survive, and also brings out the planning and integrated neurosurgical training imparted that time by dozen of well known centres with facilities of Neurology, Neuroradiology, Neuropathology and Neuro-Chemistry etc. Next two decades, showed exponential growth of number of centres and number of persons trained with quality of work being done at clinical, experimental and academic levels. The meager number of Neurosurgeons at 1970, was 58 as compared to 325 neurosurgeons in the year 1989 is a good testimony of exponential growth, of centres and personnel all over the country.

The current review will be the eye opener for facts of development of neurosurgery in a 20 year period, from 1989 to 2008, the period of superspecialisation. Thus vastly, 1<sup>st</sup> decade for formation, followed by 2 decades of growth and consolidation, current period can be well described as development of superspeciality and modernization of neurosurgery.

## **Progress**

Neurosurgery has progressed several folds over last two decades, substantiated by the facts that there are over 1200 well-trained neurosurgeons today as compared to 325, in 1989. The figures from various cities also support the above notion (Table 1). More than 20 neurosurgeons are practicing in large number of cities like Cochin, Coimbatore, Chandigarh, Madurai, Ahmedabad, Poona, Nagpur, Jaipur, Indore etc. Number of neurosurgical training centres has gone up tremendously. This is because of the fact that DNB, and M.Ch courses are running parallel and also 6 years and 3 years courses are going on regularly. In Delhi and Mumbai, 6-8 centres are involved in the training process. More importantly, neurosurgery has spread to areas which were not covered earlier, like north eastern state, Assam, J & K, Chhatisgarh and Uttaranchal. Centres have come up in Dehradun, Haldwani, Gauhati, Shilong, Imphal, Jammu, Raipur, Ranchi and in many more small cities.

With arrival of CT, MRI, SPECT, PET, large number of neuroradiological centres have come up. This is proved by the fact that in Delhi there are 60 CT scanners and over 30 MRI scanners. More surprising, there are 8 PET facilities in Delhi. More encouragingly similar facilities have come up in other metros like Mumbai, Chennai, Hyderabad, Bangalore, Thiruvananthapuram, Kolkata and Chandigarh etc. In the recent years, the growth has percolated to smaller cities like Bhubaneswar, Vizag, Vijayawada, Kochin, Ludhiana, Agra, Jaipur, Jammu, Ranchi, Coimbatore, Pondicherry, Bhopal, Jabalpur, Badodara, Surat, Nasik, Mangalore, etc. This has provided facilities to people, those who have otherwise failed to reach big and crowded centres.

**Number of Neurosurgeons**

Delhi	130
Mumbai	90
Chennai	60
Kolkata	40
Bangalore, Hyderabad & Thiruvananthapuram,	approx. 25-30 each
Coimbatore, Chandigarh, Lucknow	

**Training**

Neurosurgery training has spread over the country during the last years. Even though, the training started and spread in south rapidly, over the years neurosurgical training has started in all states except, northeastern region. Currently, 30-40 students pass out neurosurgery MCh every year. Since last 2 decades, DNB training in Neurosurgery has also been going on side by side. Large number of hospitals with adequate training facilities and manpower train DNB neurosurgery. In Delhi alone, RR Hospital in army, Apollo Hospital and Sir Ganga Ram Hospital are accredited for the training DNB students.

More recently, large number of centres have started short term training like, Spine fellowship, Pediatric neurosurgery training, cerebrovascular training etc. Every year several workshops and hands on training programmes are organized to train young neurosurgeons in their chosen superspeciality. Since 2000, Micro-neurosurgery workshops have become a part of training at All India Institute of Medical Sciences, also Voluntary Health Services at Chennai. Similarly, in 1990s large number of Skull Base workshops and Cadaver dissection training programs were conducted by AIIMS, New Delhi, KEM Hospital, Mumbai, NIMHANS, Bangalore and Sri Chitra Thirunal Institute of Medical Sciences, Thiruvananthapuram. In last few years, neuro-endoscopy workshop and spinal instrumentation workshops are regularly conducted.

Neurological Society of India and WFNS (India Trust) provide traveling fellowship for the resident doctors to attend conference, workshop and symposia. WFNS (India Trust) under able guidance of Dr. A.K. Banerji, also provide partial

financial assistance to young neurosurgeons to go abroad and get short-term training. This has become a reality in last 20 years. WFNS (India Trust) also helps in holding workshops and symposia at various centres in India.

One more remarkable development happened in the field of training is Asian CNS, under Dr. T. Kano, who started lecture programme in 1993 in Osaka, 1995 at Sapporo, etc. The aim and objective was to train large number of neurosurgeons from developing countries of Asia, by paying them for travel and accommodation. Conference held every two-year, used to benefit 200-300 young neurosurgeons every time, amongst them 30-40 belong to India. Thus, over last 15 years, hundreds of young neurosurgeons have got the benefit of the lecture program, undertaken under the banner of Asian CNS.

### **Development of super specialties**

Currently, large number of super specialties are available in neurosurgery. Fortunately, in India we have quickly adapted to the situation and to progress along with rest of the developed world. We have developed our subspecialty. By and large, credit goes to the senior neurosurgical colleagues and heads of the departments of various Institutes and corporate hospitals. Currently we have following subspecialties worth mentioning, (a) Pediatric Neurosurgery, (b) Neuro-trauma, (c) Skull Base, (d) Cerebro-vascular (e) Spinal instrumentation, (f) Epilepsy and functional neurosurgery etc.

#### **(a) Pediatric neurosurgery**

International Society for Pediatric Neurosurgery (ISPN) was started in 1972. However, it only became apparent when ISPN annual meeting was held at Mumbai in October, 1989. A small beginning was made and Indian Society of Pediatric Neurosurgery was created in the year 1990, under the leadership of Dr. S.N. Bhagwati, Dr. A.K. Banerji and Dr. S. Kalyanraman. Over last 19 years the membership has crossed over 100 and more importantly annual conference is organized every year with live surgery workshop. It is also important to mention that over last 20 years a large number of neurosurgeons in India have been initiated in the field of Pediatric Neurosurgery. This has resulted in recognition by International Society and the ISPN Annual meeting will be held at Goa, in 2011. The Education Committee of International Society for Pediatric Neurosurgery has conducted CME programmes in 10 centres in India, during that time, 5-6 eminent faculty in the field of Pediatric Neurosurgery delivered the guest lectures, over a period of 3-4 days. These types of programmes have been conducted at Mumbai, Bangalore, Kolkata, Chennai and Delhi. The programme has expanded the scope of training for young neurosurgeons in the field of Pediatric neurosurgery. The Indian Society is also publishing a Journal, under the name of Journal of Pediatric Neurosciences.

## **(b) Skull base surgery**

First International Conference of Skull Base Surgery was held at Hannover, Germany, in 1992, and amongst the 800 participants, 4 were from India. Dr. S. Bahadur and Dr. A.K. Mahapatra started a Skull Base Clinic at AIIMS in 1988. First Skull Base conference was held at AIIMS in 1989, just following the World Congress of Neurosurgery at Delhi. Subsequently, live demonstration and cadaver dissection in the field of skull base was organized at AIIMS by Dr. A.K. Banerji and Dr. A.K. Mahapatra in the year 1992, 1995, 1996, 1997. During these four Skull Base workshops, Dr. C. Sen, Dr. Laligam Sekhar, Dr. Meninges, Dr. Peter Kataliono and Dr. S. Siang participated at different time. These workshops were the turning points in the history of Skull Base Surgery in India and provided opportunity to over 200 young neurosurgeons, and initiated them in the field of Skull Base. Currently, there are several Institutes, having the facility for cadaver dissection, and also conduct Cadaver Skull Base workshop. To name a few, KEM Hospital under the leadership of Dr. A. Goel, and AIIMS under leadership of Dr. A.K. Mahapatra and Dr. A. Suri.

In 1998, Skull Base Surgery Society of India (SBSSI) was registered in Mumbai and Dr. S.N. Bhagawati was President and Dr. A.K. Banerji was Vice President. 1st Skull Base conference was held at Vigyan Bhawan, Delhi, in Oct. 1998. Over the years the conference was held in Delhi, Mumbai, Kochin, Chennai, Chandigarh, Thiruvananthapuram, etc. Currently there are over 150 members and the Society regularly conducts a workshop during the annual conference. Thus, the SBSSI has successfully imparted training to large number of young neurosurgeons in last 10 years. Books and chapters are also published by large number of Indian neurosurgeons in the field of Skull Base Surgery.

## **(c) Field of Neurotraumatology**

Neurotrauma (Head and Spinal Cord injury) is an integral part of Neurosurgery. Large number of neurosurgical centres also manage peripheral nerve and brachial plexus injury. Over last 20 years, the management of head injury and spinal injury has changed tremendously. This is because of the fact that (a) large number of private and corporate hospitals have come up in India, (b) with advent of CT and MRI, delineation of brain and spinal cord pathology has become easier, and (c) spinal instrumentation and overall spinal injury, has attracted the attention of neurosurgeons, which was earlier considered as the orthopedic problem and had not received due attention by the neurosurgeons.

Neurotrauma started as a subspecialty under NSI, in 1991, and it was named as Neurotrauma Sub-committee of NSI. The first meeting was held at Hyderabad, and subsequently meetings were held at Madurai, Bombay, Cochin, Chandigarh, Varanasi etc. During the period 1991-1997, Dr. M. Sambhasivan, Dr. I. Dinakar, and Dr. A.D. Sehgal continued as Chairman of Neurotrauma sub committee. In the year 1998 the "Neurotrauma Society of India (NTSI)" was formed, Dr. Ramani,



Dr. Banerji, Dr. Mohanty, Dr. R. Shandra, Dr. A.K. Mahapatra, Dr. V.K. Jain, Dr. A.K. Singh and Dr. G.K. Prusty became the President. Society holds annual meeting every year in August. Currently, there are over 200 members and the newsletters are published regularly. In the year 2004, the Society started publishing journal biannually, under the Editorship of Col. H.S. Bhotae. The journal is regularly published and circulated. Thus, over last 2 decades the approach to Neurotrauma has changed in India.

#### **(d) Indian Society for Stereotaxy and Functional Neurosurgery**

Stereotaxy had received a great deal of attention in 1960-1980, thanks to Dr. Rammamurthy, Dr. Balasubramaniam, Dr. Kalyanramman and Dr. Kannaka. Since 1990, over a dozen of centres have been performing stereotaxy in India. However, with the upcoming of epilepsy surgery, X and Gamma knife, new society was formed in 1995- 1996 and Dr. A.D. Sehgal was the President. Dr. V. Rasekhar was the secretary. The society holds conference every year in the month of November and there are over 100 members. Epilepsy and functional neurosurgery got a boost through the society and young neurosurgeons have taken interest. Epilepsy surgery started in Sri Chitra Thirunal Institute, CMC Vellore and AIIMS in mid 1990s, and currently more than 10-12 centres in India are engaged in management of intractable epilepsy by surgery. More importantly, deep brain stimulation is carried out in many centres in India and in Delhi alone 3-4 centres are performing deep brain stimulation, spinal cord and vagus nerve stimulation etc.

With arrival of Linear acceleration in India, X knife was started at Chennai, Delhi, Vellore, Mumbai and Bangalore for the deep seated AVM and also for IMRT. However, first Gamma Knife was installed at PD Hinduja Hospital, Mumbai, in Nov. 1996, followed by at AIIMS, in April 1997, and VIMHANS, New Delhi in the year 1998. Currently, there are 5 Gamma Knife centres in India, in addition to above mentioned 3 centres. State of the art new model Gamma Knife is functioning at NIMHANS, Bangalore and PGI, Chandigarh. Initially, Dr. B.K. Mishra, from Mumbai, Dr. V.S. Mehta, Dr. V. P. Singh, Dr. S.S. Kale, Dr. Sandeep Visya, from AIIMS were trained. In the year 1996-1998, Dr. Gaur was trained at Japan, who started Gamma Knife Surgery at VIMHANS, New Delhi. Currently, Gamma Knife Surgery is carried out in India for various neurosurgical problems, like (1) AVM, (2) Meningioma (3) Acoustic neuroma (4) Pituitary adenoma (5) Metastasis, (6) Glomous tumor, etc. Rarely Gamma Knife treatment is also offered to patients with Trigeminal neuralgia and intractable epilepsy. Largest number of patients treated by Gamma Knife in India, is at AIIMS, which is approximately 2500 cases followed by PD Hinduja hospital and Mumbai and VIMHAS Hospital. Over 200 cases have been treated at NIMHANS. Thus, in India functional and stereotaxy surgery has been developed at par with advanced countries. Hence, no patient is referred out of India for these procedures. Moreover, as these facilities are not available in Middle East and other south-east Asian countries, patients from these countries come to India. It is also cost effective for patients coming from outside India.

### **(e) Indian Society of Cerebrovascular Surgery**

The Society is the youngest subspecialty, started in 2001. Currently, there are approximately 100 members. The society is involved in education and research. In last several years, the Society conducts annual conference and helps younger colleagues.

## **NEUROSURGERY DEPARTMENTS AT VARIOUS PLACES AND THEIR CURRENT STATUS**

### **Department of Neurosurgery, NIMHANS, Bangalore.**

#### **History**

The department of Neurosurgery was started at NIMHANS, Bangalore in 1958 by Dr. R.M. Varma. He was assisted by Dr. G.N.N. Reddy in shaping the department in its early stages. The post graduate neurosurgical program was started in 1971, the first in the state of Karnataka, and one of the earliest in the country. Dr. B.S. Das joined the department in 1981 and was instrumental in the growth of the department and introduction of many specialized neurosurgical services and facility. Dr. KVR Sastry and Dr. Chandramouli, succeeded him as the Heads of the Department.

#### **Faculty and services available**

Neurosurgery Department has made a treatment program in last 20 years under the leadership of Dr. BS Das and Dr. KVR Sastry. Dr. Das retired in 1997 and Dr. Sastry who took over, has taken VRS in 2004. Dr. Chandamouli headed the Department from 2004-2008. The department is currently headed by Dr. B. Indira Devi. There are three professors, one associate professor and seven assistant professors. The department has 3 teams, each headed by a Professor. A twenty bedded new Golden Jubilee intensive care unit equipped with ventilators and monitoring facility has been commissioned in September 2008.

The department has seven operating theatres utilized for elective and emergency neurosurgical operations. Elective surgery is performed five days a week. Emergency neurosurgical operations are performed round the clock on all days. All elective operating theatres are equipped with operating microscopes. In addition to the routine services, the department has acquired expertise in providing care for specialized neurosurgical problems.

#### **Stereotactic Radiosurgery**

Stereotactic radiosurgery for brain tumors was started at NIMHANS in 2006. The department possesses Leksell 3C gamma knife system for administering conformal stereotactic radiosurgery. More than 200 procedures have been performed till date and at present about 5 to 6 procedures are performed in a week.

## **Manpower training**

The department provides training to largest number of neurosurgical residents in the country. Every year, six students are selected for the MCh neurosurgery program, three students for 5-year course and three for 3 yr course. They are trained comprehensively in all spheres of neurosurgical practice. The interactive academic programme cover all aspects of the training. The department provides training to neurosurgical postgraduate students from other institutes as a part of exchange program, as well as short term training to post graduates pursuing ENT and General surgery. More than 100 students have completed the training and have been instrumental in setting up neurosurgical facilities in many parts of the country.

## **Department of Neurosurgery, SGPGIMS, Lucknow (1989- 2008)**

### **Infrastructure**

The department started in 1986 with two faculty members; however, the clinical work started in 1988 with 10 beds and one operation theatre. Now it has grown to ten faculty members, 12 residents, 4 operation theatres, neurosurgical ICU of 15 beds with a total of 75 beds. The neuro-otology and neuro-opthalmology departments are two integral parts of the department since it's foundation. During this period the department has endeavored to achieve three major objectives; (1) specialized high quality patient care (2) postgraduate training and (3) research in neurosurgery.

The neurosurgery department is located in 8<sup>th</sup> floor of the hospital building with 2 (30 bedded) units, each containing 24 general beds and 6 private beds. It has a fully independent neurosurgical ICU with 15 well-equipped beds having multi-para vitals-monitors, multi gadget ventilators and a central monitoring desk. The neurosurgical ICU is managed by neurosurgeons round the clock and bed to caretaker ratio is 1/1. Just next to neurosurgical ICU is neurosurgical operation theatre complex with 4 OTs. The department has four state of the art modern operation theatre complex with latest Pentero Microscope (a total of 4 microscopes), Dragger-Fabius anesthesia machines, monitoring system, CUSA, mobile C-arm, intracranial Doppler, intraop Ultrasound and and 3 high speed Midas Rex drill. All necessary micro-neurosurgical instruments as well as fully functional neuron-endoscopy system, added to the OT system. Hospital was one of the first institutes in the country to have magnetic resonance imaging (MRI), way back in 1990. Now it has a 1.5 tesla MRI machine and a 3 Tesla machine is likely to be functional in six months time. A 40 Slice and 64 slice CT scan machine are working round the clock. Hospital is one of the 27 regional cancer centers (RCC) with a fully functional High and Low energy Linear Accelerator and X-knife and multiple CT Simulators to help IMRT and confirmal radiation therapy. The Department is also having Leksell stereotactic frame since 1990, and MRI compatible frame has been ordered.

Dr. D. K. Chhabra joined the department as professor & HOD and Dr. Piyush Mittal joined as assistant professor in 1986. Dr V. K. Jain joined the department in 1987 as additional professor of neurosurgery. He was promoted to Professor of neurosurgery in 1999. Dr. Deepu Banerjee joined and Dr Piyush Mittal promoted to associate professor in 1990. Dr Deepu Banerjee was promoted to additional professor in 1996 and professor of neurosurgery in 2004. Prof. Deepu Banerjee resigned from service in 2005. Dr. Raj Kumar, Professor and Dr Sanjay Behari, Additional Professor joined this department in 1996 as assistant professors. Dr. Awadhesh Kumar Jaiswal joined the department as assistant professor in 2004 and Dr Manish Singh Sharma joined the department as assistant professor in 2004. Dr. Sharma resigned in 2005 and Dr. Rabi Narayan Sahu joined the department as assistant professor in 2007. Dr Arun Kumar Srivastava joined the department as assistant professor in 2008.

The neuro-ophthalmology and Neuro-otology units are functioning since 1990. Dr. Isha Tyagi and Dr. Kumdini Sharma joined the department as assistant professor in 1987 and both have been promoted to professor and additional professor respectively in 2007. Dr. Vikas Kanujia joined as an assistant professor neuro-ophthalmology, department of Neurosurgery, in 2007. Post Doctoral Fellow in neuron-anaesthesiology started 5 years back and every year 1 candidate being trained.

### **Academic curriculum**

The post graduate super-specialty courses in neurosurgery started in 1989 with two residents. So far 48 students have passed from the institute. Two students have received prestigious Dr. SS Agrawal oration gold medals and many students have won different oration gold medals in various conferences. Since 2007, the institute has commenced two PDF (Post Doctoral Fellowships) courses in the department with one student already passed out in Pediatric Neurosurgery (PDF).

### **Health care**

The department initially had 2 OPDs per week in 1988 and now it has 6 days OPD per week. Saturday is dedicated to Pediatric Neurosurgery clinic. A diverse range of neurosurgical patients come here for treatment. Tumors like glioma, meningioma, neurofibroma, acoustic schwannomas and all varieties of spinal diseases are managed in the department. The department has achieved excellence in treating cranio-vertebral junction (CVJ) anomalies. Over 2000 patients are operated per year and OPD attendance goes beyond 15000 per annum, including new and old cases.

### **Research and Publications**

There have been more than 100 scientific publications by the department. Some of the landmark publications are in the field of Skull base tumors, Vestibular

schwannoma surgery and surgery of the CVJ anomalies as well as in Pediatric Neurosurgery. Over the years, Department organized 3 national and 2 international conferences. NSI conference is scheduled to be held at SGPGI in December 2009. Currently, Department is undertaking a multinational study, International Infant Hydrocephalus Study (IIHS) comparing role of Endoscopy versus V.P. Shunt in Congenital Hydrocephalus, due to aqueductal stenosis, under 1 year of age. There are 20 centres in the world and only two from India at AIIMS, and SGPGI, both under the guidance of Dr. A.K. Mahapatra. Department is also going to start in 2008, two multinational FDA approved studies (a) IL13 in recurrent GBM and (b) Ap 12009 G005 – TGF $\beta$  antagonist intratumoral therapy in recurrent grade III glioma. Thus, Neurosurgery Department of SGPGI has made a significant clinical, academic and research impact in Indian scenario.

### **Department Of Neurosurgery at P. D. Hinduja National Hospital and Medical Research Centre, Mumbai**

It is a leading Referral Centre for surgery of Acoustic Neuroma, Cerebrovascular Surgery, Surgery of Skull Base and Minimally Invasive Neurosurgery and is the 1)first Centre to have Gamma knife Radiosurgery in India (Started January, 1997),2)The World Federation of Neurosurgical Societies Education Centre (Class A) for Skull Base Surgery under the Directorship of Dr. B. K. Misra.,3) First centre in the world to perform Image Guided microsurgical clipping of Aneurysms by Dr. B. K. Misra.

Dr. Misra has been President, Neurological Society of India, 2008, President, Asian Conference of Neurological Surgeons, 2004 – 2006, President, Skull Base Surgery Society of India, 2002 – 2004, Guest Member, Japan Neurosurgical Society, Dr. B. K. Misra has been the first Indian Neurosurgeon to do Awake Craniotomy for Epilepsy in India, a pioneer in Image Guided Surgery and surgery for third ventricle in India, pioneer key hole concept in Spine Surgery in India.

### **Dr.Achanta Lakshmiopathi Neurosurgical Centre, Chennai**

The Dr.Achanta Lakshmiopathi Neurosurgical Centre was established in February 1978 at the Voluntary Health Services Hospital in Chennai. Dr. B.Ramamurthi, after retiring from government service at the age of 56 years set up this department sharing a few beds and the operation theatre with the general surgeons. The first one to join the department as his assistant was Dr. M.C. Vasudevan. After him Dr. A. Vincent Thamburaj and Dr. B. Dibbal Rao joined the department. In 1981 a new building was commissioned and the neurosurgical bed strength was 25 beds. There was a separate neurosurgical operation theatre. This was possible due to a large donation given from the “Arogya Ashrama Samithi” trust created by Dr. A. Lakshmiopathi. Therefore, the department has been named Dr. A. Lakshmiopathi Neurosurgical Centre. In 1991 the department was extended with addition of twenty beds and neurosurgical operation theatre. The 5 bedded neurosurgical intensive care unit was started in 1995. It is called K.R. Sundararajan

Neurointensive Care Ward, and has been equipped with a generous donation of Rs.15 lakhs by the family of Shri K.R. Sundararajan.

In 1985 the DNB course in Neurosurgery was started, the first of its kind in the country. Initially one student was taken per year and then it was increased to 2 students per year. More than 20 neurosurgeons have been trained in the department and are presently working in different parts of the country.

In 1992 a library, exclusively for neurosciences, called Vijayalakshmi Narayanan Neurosciences Library was inaugurated. There are more than 4000 books available. The anaesthesia department was initially manned by Dr. R. Chandrasekar and later on by Dr. V.K. Mythili and Dr. Usha Vijayaraghavan.

In 1994 the Annual Microneurosurgery Workshop was initiated and this has been conducted every year with 2 visiting faculty along with department faculty and staff. The ALNC day oration was started in 1992 and Dr. V.Balasubramaniam delivered the first oration.

The first edition of the Text Book of Neurosurgery was brought out in 1980 with Dr. B. Ramamurthi and Dr. P.N. Tandon as editors. In 1993, a need was felt to update the book and it was completed and published in 1996. The editors of the updated book were Dr. B.Ramamurthi and Dr. P.N. Tandon and Dr. Ravi Ramamurthi and Dr. K. Sridhar were associate editors. In the year 2005 the Text book of Operative Neurosurgery was published. At present there are four faculty members and seven residents and, the total bed strength is fifty.

### **Department of Neurosurgery, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram**

Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram (SCTIMST) became an Institute of National importance under Department of Science Technology, government of India, in the year 1980 by the Act of Indian Parliament. It was in 1976 that combined neurology and neurosurgery services started at SCTIMST, as a single department having a total of 46 beds and 2 operation rooms. Dr. K.K. Jain was Professor of Neurosurgery and Dr. P.T. Raman was the Professor of Neurology. Dr. George Mathew took over as head of the Department in 1978 and established it as an independent department. Though his main interest was spinal surgery, he can be credited with popularizing transsphenoidal pituitary surgery in India. Dr. D. Rout succeeded him in 1981. Under his stewardship, this department progressed to a center of excellence for cerebrovascular surgery and neuro-oncology neurosurgery. The department was shifted to a newly constructed surgical block in 1984 having 44 beds including 12 bedded ICU with all modern facility and 3 well equipped operation theaters. Dr. R.N. Bhattacharya took over as head from Dr. Rout in 1996. Dr. Bhattacharya started total excision and facial nerve preservation in acoustic neuroma for the first time in India way back in 1984. Skull base surgery and surgery for acoustic neuroma



developed to its excellence under Dr. B.K. Misra and the same high standard is currently maintained by Dr. Suresh Nair. The department progressed gradually and the number of neurosurgical operations almost doubled. Five additional beds were added to take the total number of beds to 49. A new well-equipped state of art operating theatre was also commissioned in 2000. Surgery for epilepsy was started in 1995 and a comprehensive center for treatment of epilepsy was established subsequently. Dr. Rout headed the Depart till 1996 and was succeeded by Dr. R.N. Bhattacharya.. Both Dr. Rout and Dr. B.K. Mishra resigned in 1996. Dr. Suresh Nair took over as Head of the Department in 1999. He was instrumental in development of CV junction surgery. In his guidance surgery for skull base lesions got a momentum and various skull base approached were practiced routinely. Functional and stereotactic neurosurgery was started with surgery for Parkinson's disease and other movement disorders in 1998. Neuroendoscopy got a boost after the successful conduct of a workshop by Dr. Perneczky in 1999. The current thrust areas include spinal instrumentation, surgery for stroke and minimally invasive neurosurgery. Operation theatres are well equipped and have state of the art devices including image guidance, stereotaxy, high end microscopes, intra-op electrophysiological monitoring devices, CUSA, pneumatic high speed drills and intraoperative ultrasound, to keep the pace with fast developing neuroscience.

## **Academics**

This Institution of National importance, it has the status of a Deemed University and offers regular training programme leading to MCh degree. There are also facilities for DM neuroradiology and post-doctoral certificate courses (PDCC) in anesthesia. Postgraduate training program in neurosurgery was started in 1982 and till date 60 neurosurgeons have passed out from this centre. Postgraduate students have successfully established themselves and are working in different parts of India and abroad. Some of them are heading their respective departments. The neurosurgery department has been recognized as a center of excellence for training of the overseas residents and junior consultants. Considering the necessity of sub-specialization in neurosurgery, a post-doctoral fellowship (PDF) course in cerebrovascular surgery has been started and subsequently such fellowships will be introduced for the other subspecialties. Department is aiming to establish a state of the art cadaver dissection laboratory with facilities for training for residents.

Currently, department of neurosurgery has 8 faculty and 13 resident positions. There are a total of 63 beds including 13 ICU beds. Department does not entertain trauma or emergency patients. There are 4 dedicated operation theatres and approximately 1300 operations are performed annually.

## **Research**

- A) Hydrocephalus shunt system was developed in 1993 in collaboration with biotechnology department. TTK company is commercially marketing this as Ceredrain.

- B) Indigenous fibrin glue has been developed in collaboration with biotechnology wing, and is due for market launch.
- C) Burr hole buttons using Hydroxyapatite bone substitute, have completed clinical trials and are available in the market.

Future research areas include artificial dural substitutes, non-invasive ICP monitoring devices. A preliminary project on mucoid vasculopathy has been started to study possible etiological factor for aneurysm formation in this part of the country.

## **Neurosurgery at Neurosciences Centre, AIIMS, New Delhi**

### **Faculty**

Neurosurgery started at AIIMS in 1965, with 2 faculty members. The number increased to 4 in the year 1975 and six by the year 1985. Currently, there are 18 posts, among those three professors, one additional professor, 3 associate professors and 11 assistant professors. Among the assistant professors, 5 posts are for trauma centre and one for the Gamma Knife centre. The department is the largest and the best in the country, with 18 faculty members and 45 residents. It attracts large number of visiting neurosurgeons from India and abroad.

### **Services**

Department of Neurosurgery has over 170 beds, including 60 beds at the Trauma center. Among 170 beds, 40 beds are ICU beds of which 15 are Trauma ICU cases. There are over 50 ventilators. Department is running out patients 4 days a week and admits over 6000 cases annually of which 4500 get operated. There are 9 operation theatres (including 2 at Trauma Centre) with all facilities, 10 microscopes, 8 Midas Rex drills, Image guidance system, Transcranial Doppler, Evoked Potential machine, Intraoperative US, five cavitron ultra suction apparatus. There are also intraoperative nerve stimulators, Pal magnetic system for cutting and vaporization of tumor and intraoperative cell saver for autotransfusion. Intraoperative MRI (Brain suit) with a cost of Rs. 20 crore is under installation.

### **Education**

Department runs 3 years Post MS and 6 years residency programme following MBBS. The department has trained over 150 residents, since 1967. The residents get a good exposure to clinical work, academic and research and experience as they assist, all types of neurosurgical cases including deep brain stimulation, Gamma Knife and get exposure to epilepsy surgery.

### **Conferences**

Department organized large number of workshops, conferences, symposium and orations. Skull base workshop with cadaver dissection was organized in

1992, 1995, 1996, 1997 and 2007. One day conference on Gamma Knife was organized in 1994. First national conference in Gamma Knife was organized, in April 2007, to mark the completion of 10 years of Gamma Knife at AIIMS. In 1994, 4 days Midas Rex hands on workshop was organized by Dr. A.K. Mahapatra. There were 10 workstations, 20 neurosurgeons were trained, and 10 each were trained for 2 days. In 1995, Microneurosurgery conference was organized for a period of 3 days, six faculties from US and Europe participated. Since 1999, Department has been organizing AIIMS Microneurosurgery workshop annually, along with Sarveswari Oration. Every year one eminent neurosurgeon is invited for delivering the oration. Since 1990, Mr. R.P. Sengupta, Dr. Mathai, Dr. Jacob Abraham, Dr. Kanno, Dr. Briccolo, Dr. David Mendelo, Dr. H. Kokhom, Dr. Suzuki, Dr. Rebert Hero, Mr. Alan Crocarl, Dr. Sambhsivan, Dr. Sano etc. have delivered the oration. Department of Neurosurgery organized Head injury conference for police, nurses and ambulance drivers in Dec. 2003, 2004, 2005. In Oct. 2007, Department, organized Annual conference of Skull base Surgery Society of India. Thus, Department has actively participated in conferences, and imparting microneurosurgery and skull Base training.

### **Subspecialty**

Department has been in the forefront of subspecialisation and faculty members headed various societies as office bearers. Dr. A.K. Banerji, has served as the President of NSI, Dr. Mehta, its Treasurer and President and. Dr. A.K. Mahapatra, served as s Treasurer, Secretary and President of Neuro-otological Society of India. He also worked as Secretary and President of Neuro-trauma Society of India, Skull Base Surgery Society of India and currently, is the Vice-President of Indian Society of Pediatric Neurosurgery and Vice President of Indian NMR Society. Dr. A.K. Mahapatra is member Executive Council of Asian-Oceanic Skull Base Society and International Society for Pediatric Neurosurgery. He is the founder member of Asian CNS, started way back in 1993.

### **Editorial activities**

Dr. A.K. Mahapatra is on Editorial Board of Pan-Arab Journal of Neurosurgery, Journal of Clinical Neurosciences, Neurotherapeutics, Associate Editor of Child's Nervous System. He was also on editorial board of Neurology India, Neurosciences Today, Journal of Pediatric Neurosciences, and Asian Archives of Critical Care Medicine.

### **Awards received**

Since 1990, faculty of the department has received large number of Awards. Dr. P.N. Tandon received Padma Bhushan in 1991, Bhatnagar Fellow of CSIR and Meghnad Saha Fellow of National Academy of Sciences, received Padma Vibhushan in 2007, Dr. V.S. Mehta received Padma Shri and Fellow of The National Academy of Sciences, India, Dr. A.K. Mahapatra received Fellowship of The National

Academy of Sciences, India in 2004, UP Ratan Award in 2007 and Dr. B.C. Roy Award in 2007. Faculties and residents received large number of best paper awards, traveling fellowship etc. Thus, the Department is proud of the faculty and residents.

Dr. Banerji headed the Department in 1988-1990 and also worked as Chief of Neurosciences Centre at AIIMS from 1990-1995. Dr. Ravi Bhatia headed the Department from 1991-1994. Dr. V.S. Mehta headed the department from 1995-2005 and was Chief of the neurosciences centre from 2001-2005. Dr. Mahapatra headed the Department from 2005-2006. Since October 2006, Dr. B.S. Sharma is heading the Department. Dr. Mahapatra took leave and joined as Director of SGPGIMS at Lucknow.

## **Publications**

Faculty members of Department of Neurosurgery at AIIMS have published over 500 papers in last 20 years. Dr. P.N. Tandon revised the book “Text Book of Neurosurgery”, Ramamurthy and Tandon, 2<sup>nd</sup> Edition in 1996 and 3<sup>rd</sup> Edition is due for publication. Dr. A.K. Mahapatra published basic guidelines of management of Brain and Spinal Cord injury as a Co-author with Dr. P.S. Ramani and along with. Raj Kamal edited “Text Book of Head Injury” in 1999. The second edition was published in 2002 and the 3<sup>rd</sup> edition in 2005. Dr. A.K. Mahapatra, Dr. P. Sarat Chandra and Dr. Raj Kumar edited “Text book of Brain Haemorrhage” published in 2007. A large number of chapters have been contributed by the faculty members to various books.

## **Research**

Research has been the backbone of Department of Neurosurgery at AIIMS, under the guidance of Dr. P.N. Tandon, subsequently under Dr. V.S. Mehta and Dr. A.K. Mahapatra. Department was actively involved in Glioma studies, which included, long term survival, recurrence, role of repeat surgery, recovery from speech problem and treatment of brain stem glioma.

Department conducted large number of study in head injury relating to TCD, ICP monitoring, evoked potential, cerebral blood flow, P300 in concussion, SPECT in minor head injury by Dr. Mahapatra pioneered the work on traumatic blindness, proved the role of VEP and established the role of surgery in traumatic blindness.

Department is involved in national and international collaborative study. Dr. A.K. Banerji and Dr. A.K. Mahapatra were involved in multicentric study of cerebral drain shunt. Dr. A.K. Mahapatra was involved in multinational optic nerve injury study (IONTS) in 1994-1996, only centre in India amongst 32 centres in the world and contributed 18 cases, the largest number by a single centre. Dr. V.S. Mehta was involved in STICH study (2001-2003). Dr. A.K. Mahapatra was involved in FDA approved, AP 12009-TGFB intratumoral therapy and contributed largest number of patients (17) in 2004-2005. He is also involved in another FDA approval study

COTARA (I 131 label monoclonal antibody) in multinational study IIHS. Dr. A.K. Mahapatra and Dr. Manmohan Singh have been involved in CRASH-2 study.

### **Laboratories**

Department of Neurosurgery runs a animal experiment laboratory since mid 1970 with microscope and high speed drill. Large number of faculty and residents from neurosurgery got microneurosurgery training over last 30 years. Department of Neurosurgery started electrophysiology laboratory with facility for ABER, VER, SER, P300 wave, TCD and Trigeminal and facial nerve stimulation facility. Department also started with median nerve conduction for aeromegaly, myxidema etc. Over 20,000 evoked potential studies were carried out since 1982 till 2006, under guidance of Dr. A.K. Mahapatra. Intra-operative monitoring of EP during CVJ and split cord malformation etc. was also carried out. Intra-operative monitoring of facial nerve, rootlet of brachial plexus is regularly carried out during surgery. The first neurophysiology and intra-operative neurophysiological monitoring was started more than 20 years back. Electrocardiography started in 1994, and more than 700 patients operated for epilepsy. In 2006, by FIST grant of DST, a cadaver dissection lab started with two workstations with microscopy, high-speed drill, instruments and endoscope. This has facilitated further training at AIIMS.

### **Department of Neurological Sciences, Christian Medical College, Vellore**

#### **Achievements**

First Department of Neurological Sciences in the country and the region – 1949

First training program in Neurosurgery – 1956

First M.S. Neurosurgery trainee in the country – Dr. K. V. Mathai – 1961

First CT guided stereotactic system in the country – 1987

First Stereotactic radiosurgery system in the country – 1995

#### **Original contributions to Neurosurgery**

- (a) First publication suggesting shunt surgery for posterior fossa tumors in children – J Neurosurgery 1964. This publication was the first of its kind in the world and led to safer surgery for posterior fossa tumors in children.
- (b) First community based study of epilepsy in India – 1968. Determined the prevalence of epilepsy (9/1000) in India.
- (c) First community based study of stroke in India – 1972. Indicated that extracranial disease is an uncommon cause of strokes in Indian patients.

- (d) Use of omental transposition in patients with strokes.
- (e) Utilization of stereotactic surgery to rationalize treatment of intracranial masses in Indian patients – 1987 onwards – several publications. The department has one of the largest series of stereotactic biopsies for brain stem masses
- (f) Identified the cause of “Disappearing CT lesions” as solitary cysticercus’s granuloma – 1988.

Subsequently several publications have clarified its biology, pathology and management. This work rationalized the treatment of patients with “disappearing” lesions and saved several of them from the ill effects of empiric antituberculous therapy. This one contribution from the department probably has benefited the largest number of patients all over the country.

### **Ongoing research**

1. Studies on surgical outcomes in patients with cervical spondylotic myelopathy.
2. Experimental studies on stem cell therapy for head injury – funded by DBT.
3. Studies on intraoperative physiological monitoring using motor evoked potentials – funded by ICMR.
4. In-vitro electrophysiological studies in epileptic brain slices – funded by NCBS, Bangalore.
5. Community based study on transmission of cysticercosis – funded by the Belgian Government.

### **Contribution to Indian neurosurgery**

The main contribution has been in the training of Neurosurgeons who have gone on to work in academic departments all over the country (Kolkata, Mumbai, AIIMS (Delhi), Lucknow, Ludhiana, Jammu, Cuttack, Patna, Chennai, Trivandrum, Mangalore, Hyderabad, Vizag, Jaipur, Guwahati, Gwalior). This led to the establishment of new training programs or strengthening of existing programs in these centres leading to development of large pool of neurosurgeons all over the country. A full-fledged intra-operative neurophysiological monitoring program is running from 1991 onwards.

### **Department of Neurosurgery, PGIMER, Chandigarh**

The Department of Neurosurgery at the Postgraduate Institute of Medical Education and Research, Chandigarh came into existence in January 1962 with the joining of Dr. Des Raj Gulati as Assistant Professor of Neurosurgery. To start



with, he looked after both Neurology as well as Neurosurgical services. Working single-handed, Dr. Gulati got some assistance a couple of years after from registrars of Neurosurgery namely Dr. K. S. Mann, Dr. S.N. Dhaliwal and others. The department progressed and the first M.Ch. candidate, Dr. V. P. Sachdev obtained the degree in 1968. During the same year, with the joining of Dr. J. S. Chopra, the department of Neurology was started. Towards the end of 1969, Dr. V.K. Kak joined the department of Neurosurgery. The department progressed steadily thereafter with candidates joining regularly for M.Ch. (Neurosurgery) course. Dr. K.C. Pani was awarded degree in 1971. Dr. D. Rout joined as Lecturer in Neurosurgery in 1972. Dr. Mann following his training at England joined as a Assistant Professor in 1975. Dr.V.K. Khosla joined as Lecturer in 1977 and followed by other faculty members namely Dr.S.N. Mathuriya, Dr.B.S. Sharma, Dr.A.Pathak and Dr.M.K.Tewari. In 1992, Dr. S.K. Gupta joined as Assistant Professor. Dr. D.R. Gulati continued to head the department until reaching the age of superannuation in August, 1983. Working with great zeal and enthusiasm, he became the Dean of the Institute on November, 1980 and was Acting Director of the Institute from March, to November 1981. Dr.Kak was appointed Director-Principal of Govt. Medical College and Hospital, Sector 32, Chandigarh in 1995. Dr.Kak retired from the PGI, Chandigarh in 1998.

Dr. V.K. Khosla took over as Head of the Department in 1995 and retired in May 2008. Since inception, the workload of the department has been increasing. Starting with 24 beds, the department struggled to serve the public and cater to the heavy rush of neurosurgical work. Department caters around 70 million population from surrounding states and UT for all neurosurgical problems starting from head injuries and extradural hematoma to complex intracranial aneurysms and petroclival meningiomas. The workload is on a massive rise in all the areas but the service infrastructure could not rise at par with patient workload. Annual OPD attendance is around 16000 (192% rise over 25 years), admissions have increased by 117%, with 40% increase in beds, operations have increased by 294% (total 3161) against 116% rise in operation tables. The present bed strength is 58 trauma, non trauma and emergencies and includes 6 Neurosurgery ICU beds. There are around 20 patients in periphery + private wards, and around 30 patients under observation in emergency OPD. Around 20 patients attend emergency OPD daily. Department is operating 14 routine operation tables per week and 2 emergency tables (daily) round the clock, which include 1 to 4 aneurysmal subarachnoid hemorrhages daily. In addition to routine and emergency services during day time there are in hospital 4 senior residents on night duty in Emergency ward, Emergency OPD and Neuro ICU and Emergency OT.

Further expansion and modernization was the need of the hour due to the workload catered to by the department. A fully equipped new Neurosurgical Emergency ward was started during the renovation of the Emergency Complex in 1997-98. Thirty beds were allocated to the department of Neurosurgery in the new emergency complex. Currently, the official bed strength of the Neurosurgery

department stands of 58. Besides this, on an average, about 20 patients are admitted / taken care of by the Neurosurgery Department in the private/other wards. Another group of 35 patients are constantly under treatment in the emergency OPD area. On an average, 25 new patients report to the neurosurgery emergency OPD everyday.

Over a span of four decades, the department has catered to the needs of entire north western India, with ever-increasing number of operations, indoor admissions and out-doors patients care. Due to heavy workload and referral of serious patients from different parts of the country a 6 bedded special neuro-Intensive Care Unit was started in 2001. In spite of hectic clinical care demand, the faculty continues with research projects and national-international publications.

Training at the level of Postgraduation (MS-General Surgery) and post-doctorate (M.Ch.- Neurosurgery) has been a priority since the inception of this department as at other places. Every MS resident undergoes 3 months training in our department. A total of 100 candidates have been awarded M.Ch. (Neurosurgery).

Fifty research projects have been completed, 40 chapters were written, around 500 papers were published and around 50 theses were guided. Clinical research includes cervical spine, approaches to skull base, craniovertebral junction and use of ultrasound in neurosurgery.

Research was conducted in various spheres of the specialty, these include craniosynostosis, medulloblastoma, hydrocephalus, management of primary CNS tumors, proto-oncogene in gliomas; fungal granulomas, cytokines in meningiomas. In head injury the research was undertaken in various areas starting from basic – tissue thromboplastin to autopsy findings in severe head injuries, traumatic SAH, epidemiology and cognitive dysfunction + retraining.

Department has a substantial contribution in all spheres of aneurysmal subarachnoid hemorrhage (An.SAH). Around 260 to 270 patients of aneurysmal SAH are operated per annum and around 30 are coiled. The research include status of NO in SAH, use of sildenafil, intraventricular sodium nitroprusside and endothelin. A receptor antagonist has been investigated in management of vasospasm resulting from An. SAH. We are running a ICMR project on follow up in An. SAH patients. The department has established ultra early care in An. SAH patients. Recently a certification course in cerebrovascular surgery has been introduced for sponsored candidates.

The department is associated with drug trials in recurrent gliomas and took an active part in CRASH trial. There is a close collaboration with Neurology and supportive departments like Neuroradiology, Neuroanesthesia Neuropathology and Pediatric Neurology.

The facilities also have enhanced over the years. Senior residents sanctioned are 18 and faculty members are 13. Department is going to have additions of Gamma Knife and Advanced trauma centres in near future. There is plan to expand ICU, general ward beds and operation tables. All intra operative facilities monitoring are available and a few will be added in coming years. Department has started Prof. D.R. Gulati memorial oration as regular feature for last 3 years.

In view of the amount of clinical responsibilities the department has to render, an appropriately planned neuroscience centre is needed for ever rising demand.

### **Department of Neurosurgery at Nizam Institute of Medical Sciences, Hyderabad**

The Department of Neurosurgery was started in 1986 along with the inception of the institute. It has attracted many talented surgeons from all over India and has grown without any leaps and bounds. Today it is in a commendable stage by performing number of outstanding surgeries with the most successful rate. The department is also reached greater heights in terms of education, training, facilities and the quality of work with highly skilled Neurosurgeons.

Today, the department has got the credit that most of the best neurosurgeons were trained in this department and getting the laurels to the department as well as to the Institute. The faculty of the department keeps visiting leading medical centres of the country as well as the world to expose themselves to the latest advancements of the specialty with a view to give their best in surgical excellence to the needy and sick patients since the advanced techniques have technologically dependant to a greater extent. At the same time they are educating professionally at other centres with their expertise. It is also the leader in the field of surgical management of spasticity with special emphasis on children with cerebral palsy. Many innovative procedures have been developed in this field.

The operation theatre of the department is equipped with modern technology and its surgical intensive care units are equipped with modern life saving equipments and ventilatory supports. The faculty, residents and other doctors of the department are not only participating in CME programmes but are also actively participating in the live demonstrations, work-shops, symposiums, seminars and panel discussions to update their surgical knowledge and skills in the latest developments of the specialty.

### **Training**

Department has trained 32 neurosurgeons in last 20 years and six persons have completed spinal fellowship, which is only possible in few centres in India. Department runs M.Ch. (5 years) course, M.Ch. (3 years) course, One year Spine Fellowship course and six months Spine Fellowship course.

### ***Workshops and conferences conducted***

Live workshop on endoscopy for pituitary tumors at NIMHANS, Bangalore in 2006 during Neuroendoscopy Update. Workshop on Spasticity on<sup>in</sup> November, 2006. Live surgery demonstration on Lumbosacral selective posterior rhizotomy on<sup>in</sup> November, 2006 and on selective motor fasciculotomy for lower limb (tibial and sciatic nerves) and upper limb (median, ulnar and musculocutaneous nerves).

A workshop on “Deep brain stimulation for Parkinson’s disease” at New Delhi in 2006. A workshop on Anterior cervical spine fixations at Gandhi Medical College in 2006. Conducted camp on “Cerebral palsy” at Jalandhar, Punjab State in, 2007 and one-day workshop on “Radiosurgery” with visiting professor Dr. Dheerendra Prasad, Chairman-Gamma Knife Unit, Rosewell Park Cancer Institute, New York, USA in 2007. Dr. Manas Panigrahi conducted live Neuroendoscopy workshop at Bhubaneswar in May, 2007 and a cerebral palsy camp at Tirunelveli, Tamil Nadu from 6-10th October, 2007. he also conducted cerebral Palsy camp at Jaipur, Rajasthan from 22nd – 26th October, 07.

### **Honors and Awards**

Dr. A. Purohit was appointed Honorary Director of Institute of Rehabilitation Sciences and Jagadguru Rambhadracharya Handicapped University, Uttar Pradesh, India. Honored with Sushrut Sadhbhavana Puraskar, Hyderabad in December, 2005. Dr. A.K. Purohit was felicitated by the Chief Minister of Rajasthan at Jaipur on 28/10/2007 in recognition of the services to the field of cerebral palsy. Dr. Manas Panigrahi was awarded APNSA Gold Medal at the Annual Andhra Pradesh Neuroscientists Conference in July, 2006 for presentation on “Management of Craniovertebral Instability. Dr. Manas Panigrahi was awarded Dr. S. Balapameswar Rao Gold Medal for presentatio on “Surgical Management of Aneurysms” at the Annual Andhra Pradesh Neuroscientists Conference held at Nellore in July, 2006. Awarded APNSA Gold Medal for a invited lecture on “Skull Base Approach to Posterior Fossa Tumors” at APNSA-2007.

Several residents have also received best poster or paper awards. Dr. Arun received best poster award at the “Neuro Update” at NIMHANS in April, 2006 for presentation on “Surgical outcome of cavernous sinus lesions”. Dr. Kalyan was awarded at the 9th Annual Stereotaxy and functional Neurosurgery conference held in November, 2006 for presenting paper on “Motor outcome in Parkinson’s Disease following deep brain stimulation” and Dr. Phaniraj for presenting paper on “Surgical Outcome of Lesional Epilepsy Surgery”. Dr. Ramakrishna Reddy got the “Best Paper award” at the 54<sup>th</sup> APNSA Conference 2008 held at Hyderabad.

## **Research**

The Department is involved in intra- and interdepartmental research activity and guided many postgraduates for their dissertations / thesis. The Department participates in research collaboration with other organizations:

“Sphenopalatine Ganglion Stimulation for Stroke”, Phase-II Drug Trial on chronic spinal cord injury patients: a large randomized placebo controlled trial, among trauma patients with or at risk of significant hemorrhage, of the effects of anti-fibrinolytic treatment on death and transfusion requirement (in the name of CRASH-II); correlation between SSEP, MRI and neurological outcome (Asia Score) in complete spinal cord injuries and a study of Prognostic factors in functional outcome measures in cerebral palsy, comparative study between SPR vs ITB in spasticity.” The ongoing research project includes:

1. Multiple intracranial aneurysms
2. Review of Suprasellar meningiomas – surgical results with special consideration to ophthalmological and endocrinological outcomes
3. Pre- and post operative cognitive deficits, quality of life and psychiatric manifestations in patients with supratentorial meningioma
4. Study of morphology of posterior fossa to predict surgical approaches to CP angle tumors.
5. Diagnostic criteria of suspected intra-axial tubercular brain lesion.
6. Upper limb spasticity and proteomics in glioma
7. Role of tumor markers in diagnosis and management of pineal tumors and out come of large intracranial aneurysms.

## **Publications in Journals**

Over 100 papers have been published in various journals in last 10 years. Faculty also contributed 10 chapters in various books.

## **Neurosurgery, KEM Hospital, Mumbai**

The Department of Neurosurgery at the KEM hospital was founded by Dr. Ram Ginde in 1951 and was later developed by Dr. Homi Dastur. Dr.S.K.Pandya took over the reins from Dr. Dastur in 1976 and nurtured the department till 1998. Subspecialty neurosurgery took its roots during Dr. Pandya’s tenure and gained momentum from 1990 onwards. Dr. R.D. Nagpal was entrusted with pituitary tumors, third ventricle and cerebellopontine tumors. Dr. Anil Karapurkar, who had special training in interventional neuroradiology with Dr. Jacques Moret and Dr. L.C. Pickard, dedicated himself to interventional neuroradiology. Dr. Goel received the Boyscast

scholarship for advanced training in cranial base surgery at the Department of skull base surgery at University of Pittsburgh, for one year. Upon his return, he was entrusted with skull base surgery. Dr. Hande was trained by Dr. Sugita in cerebrovascular surgery.

Drs. Nagpal, Hande and Dr. Karapurkar left the department in 1995- 1996. After Dr. Pandya's retirement in 1998, the responsibility of this illustrious department fell on the shoulders of young Dr. A. Goel. The exponential growth in the departmental academic activities was a result of a classified standard of care, clinical research and publications. The Operating room is state of the art and equipped with advanced microscopes with neuronavigation facility, CUSA (Cavitron ultrasonic aspirator), digital equipment for data recording and advanced anesthesia setup.

Dr. Goel has 70 papers on surgical techniques published in various international journals. He has 50 chapters in books and periodicals on Neurosurgery and about 294 publications in peer-reviewed journals. He received the Indian Council of Medical Research Mrs. Shakuntala Devi Amir Chand Prize, 1995 and Amrut Mody Unichem award, 1996. He was also awarded 'Shinshu Gold Medal' by the Department of Neurosurgery, Shinshu University, Matsumoto, Japan, 1995, and Honorary Life Membership of the department for contributions in skull base and cavernous sinus surgery. He co-edited and published a book on skull base surgery - Kobayashi S, Goel A, Hongo K. Neurosurgery of Complex Tumors and Vascular Lesions.. He was in-charge of the Neurological Society of India Website - educational activities. 1999 –2002. He is a trustee of the WFNS (India) trust since 2005. He has been awarded the eminent medical teacher, Dr. B.C. Roy National award 2003.

In the last 10 years, the major achievements of the department deserve a mention. A fully equipped microneurosurgical laboratory was established in 2002 for brain dissection. The department has been recognized by WFNS education committee as Class 'A' centre for training in skull base surgery 2008-2009. Until now, about 40 candidates from foreign countries including South East Asia, Japan and Korea and 35 candidates from Indian subcontinent have availed of this facility. White fiber dissection has been the focus and is also being performed in the laboratory. The Spine surgery service was started in 1998 which was dedicated toward complex instrumentation for pathologies of the entire spine. A spine fellowship was started in 1999-2000 and has successfully trained more than 20 candidates. Department of Neurosurgery is very much involved in management of cerebrovascular diseases. In the field of epilepsy surgery, department has got good experience. Epilepsy surgery started in 1999-2000 and till date 120 cases have been operated.

Interventional neuroradiology (INR): Dr. Karapurkar was in charge of the Neuroangiography and Neurointervention program till July, 1996. Cerebral and spinal angiograms and therapeutic neurointerventions for Carotid – Cavernous fistulas, Cavernous ICA giant aneurysms and pre operative embolizations for Cerebral AVMs



and Skull – Base tumors were being performed. A Portable ‘C – Arm’ DSA machine was procured in 1994. Dr. Uday Limaye joined the Department in 1995 and following Dr. Karapurkar’s departure in 1998, took over charge of interventional neuroradiology. Dr. Limaye received specialized training under Prof. Jacques Moret in Paris, France, between 1997 and 1999. This was put to good use and the department expanded and established itself with Dr. W. Siddhartha and Dr. Manish Shrivastava who joined as faculty in the coming years. Currently, GDC coiling of intracranial aneurysms, NBCA and onyx embolization for brain AVMs to carotid and intracranial stenting, and an entire range of Neuro Interventional procedures are being performed. This center is now performing up to 1000 Neuroangioplasty and excess of 350 neurointerventional procedures per year.

Dr. Dattatraya Muzumdar, Associate Professor successfully completed clinical fellowship training in pediatric neurosurgery from University of Ottawa, Canada, in 2004 and since then has promoted the development of pediatric neurosurgery in an organized manner. Dr. Ketan Desai, Assistant Professor received the Congress of Neurological Surgeons Fellowship for advanced fellowship training in peripheral nerve surgery in 2001. He was trained under Professor David Kline at the Department of Neurosurgery, Louisiana State University, New Orleans, USA. Following his training, he started the peripheral nerve center at the KEM hospital in 2002.

### **Some remarkable achievements**

Deployment of the first self – expanding Intracranial stent in the world (Neuroform – September, 2000), INR training Fellowship commenced from 2001, Organization of yearly complications meeting and workshop, since 2003, ‘The India Neuro – Interventional Foundation’ was established in 2005, ‘Circle of Willis & Other Things’ training module were done from December 2006 to March, 2008, With modern equipment; expanded indications, high numbers, training facility and stable of the art materials and techniques, interventional neuroradiology at KEM has established itself as the tertiary referral center for Western India for Neuro – Vascular diseases and one of the best centers for Neuro-intervention, in South East Asia.

### **Neurosurgery, Bombay Hospital and Research Centre, Mumbai**

The Department of neurosurgery was housed since 1989 on the fifth floor of Medical Research Centre (MRC) building with 20 general ward beds, 4 recovery room beds and an operation theatre complex consisting of a large operation theatre with a smaller one where smaller procedures like burr-hole, shunts and spinal surgery were done. A good surgical microscope was installed in the large theatre.

When the fifteen storied new wing of the hospital was constructed, whole of the fifth floor of the new wing was given to the department of neurosurgery. Operation theatre complex was shifted to this new fifth floor. The enlarged 17 bedded post

operation recovery room (ICU) is housed next to the operation theatre complex. The ICU has full monitoring and ventilatory support. The operation theatre complex has 4 fully operational theatres with operating microscope with recording system, Datamech anesthesia apparatus with monitoring system, high speed drills, CUSA, mobile C –arm TV, and all necessary microsurgical instruments. They also have endoscopes (Aesculap and Storz) to perform third ventriculostomy and transphenoidal endoscope assisted hypophysectomy, CSF fistulas and skull base tumors. Recently latest Pantera Microscope of Zeiss and neuronavigation system and a 1.5 Tessler MRI machine and 64 slice spiral CT Scanner has been added. Also a linear accelerator for administering routine radiotherapy and attachment for giving Linac Stereotaxic Radiosurgery (SAS) and Stereotaxic Radiotherapy (SRT) have been added.

Dr. Geeta Parulekar and Dr. C.E. Deopujari were assistant surgeons till 1992. From 1993 they were promoted as full time Associate Hon. Surgeons with the right to admit their own patients. Dr. Uday Andar was appointed in 1995 as part time Hon. Associate Surgeon. In 1993 Dr. Deopujari left Bombay Hospital and joined Hinduja National Hospital. Dr. Mahesh Chaudhary was appointed in his place in 1996 and Dr. Suneel Shah in 2001. Dr. Deopujari left Hinduja National Hospital in November of 1999 and rejoined Bombay Hospital as full time Associate Honorary Surgeon. Soon Dr. Rajan Shah joined the hospital as Associate Honorary Neurosurgeon. Dr. Anil Karapurkar joined the Bombay Hospital in 2002 as Consultant Neurosurgeon and Endovascular Neurosurgeon. He performed all DSAs and interventional work on the Philip C-arm TV till he left the hospital to join Harkisondas Hospital as endovascular surgeon. Recently Dr. Sharad Ghadge has joined the hospital as endovascular interventionalist. Dr. Trimurti Nadkarni joined as part time associate neurosurgeon in December 2006.

In 1990-1991 some of the disciplines were recognized for post graduate teaching by University of Bombay and Bombay Hospital Institute of Medical Sciences was formed. It started registering 3 students every year for M.Ch. in Neurosurgery and now 9 trainee residents at a time. Initially it could take students for DNB in neurosurgery; this has been stopped since 2003 as it is taking students for M.Ch. in neurosurgery.

Dr. S.N. Bhagwati was the senior most professor and Head of the Department of neurosurgery till he retired in 1994 and became the Emeritus Professor. Dr. K.E. Turel became the head and Dr. Geeta Parulekar and Dr. Deopujari became Hon. Associate Professors. In 2000, Dr. S.N. Bhagwati became the head of the entire department of Neurosurgery.

Steadily the operative works at the Bombay Hospital has increased and at present about 1600 operations are performed per annum. It has become a tertiary centre of referral with patients being referred from all over the country and abroad. A large number of intracranial tumors, large meningiomas, skull base lesions,

pituitary tumors, acoustic schwannomas, aneurysms, arterio venous malformations, pediatric tumors like medulloblastomas and craniopharyngiomas, congenital atlanto-axial subluxations, spinal tuberculosis, intramedullary tumors, spinal trauma, cervical and lumbar disc lesions, etc. are being tackled as a routine. More of minimally invasive surgery is being performed.

It has been holding Ginde Oration since 1992 where an internationally acclaimed neurosurgeon is awarded the oration. The neurosurgeon delivers the oration on the topic of his specialty and performs live surgery and at times holds a workshop for 2 days. This is attended by nearly 100 neurosurgeons from all over the country. Large number of eminent neurosurgeons have delivered the oration. To name a few:

Dr. Madji Samii delivered the oration on “Acoustic Neurinoma & Branchial Plexus”, Dr. R.P. Sengupta on “Giant Aneurysm & Endarterectomy”, Dr. Vinko Dolenc on “Cavernous Sinus Meningioma”, Dr Robert Spetzler on “Petro Clival Meningioma”, Dr. James Ausman on “Basilar Bifurcation Aneurysm & AV Malformation”, Dr. Donlin Long on “Recent Advances in the Management of Acoustic Tumors”, Dr. Axel Pernecksy on “Endoscopic Third Ventriculostomy and Clipping of MCA Aneurysm”, Dr. Peter Janetta on “Microvascular Decompression of Trigeminal Neuralgia”, Dr. Rudolph Fahlbusch on “Advanced Techniques in Pituitary Surgery”, Dr. Tetsuo Kanno on “Accumulation of fine (small) technical improvements in Brain Tumor surgery”, Dr. Richard Hayward on “The Philosophy of Management in Craniostyosis”, Dr. Jacques Brotchi on “Intraspinal cord tumors”, Dr. Hirotishi Sano on “My History of Microsurgery”, Dr. Hae-Dong Jho on “Minimalism in Brain & Spine Surgery” and Dr. Gazi Yasargil on “Reflections on the History of Micro-neurosurgery.

Since 1989 when the 17<sup>th</sup> Annual Meeting of International Society for Pediatric Neurosurgery was held, an awakening has taken place in our neurosurgeons in pediatric neurosurgery. The Indian Society was formed in 1991 and it has been holding its annual meetings since then. For the initial 5 years; craniopharyngioma, infratentorial tumors, supratentorial tumors, craniospinal dysraphism and infection of the nervous system were the main topics. Thereafter besides symposia, fair number of free communications are being submitted at the meeting which for several years was hosted by the Bombay Hospital before other centers started pitching in and holding these meetings with a half to one day workshops.

### **CMEs in Pediatric Neurosurgery**

For last four years, Department has been organizing endoscopy surgery and cadaveric endoscopic workshop annually, with the cooperation of Lokmanya Tilak Hospital. Department is also holding Endoscopic Skull Base Surgery Workshop along with ENT surgeons annually, having the co-operation of Nair Hospital. One dozen CME were organized by the Department between 1992 and 2007.

## Clinical Interest

### Hydrocephalus

Department has been doing endoscopic third ventriculostomies for several years. Endoscopy is also used for post tubercular meningitic cases. ETV is also carried out in children below 1 year of age, though follow up has not been sufficient to know of its success. It has been performed successfully for rupture of intraventricular cysts and for septostomy in loculated hydrocephalus. Biopsy of post third ventricular tumor has been performed while doing third ventriculostomy.

**Atlanto–axial subluxation:** Antero-lateral fusion has become a common procedure. However, for its success the patient has to be kept in skull traction for almost 3 to 3 ½ months. Therefore postero - lateral fusion was thought of (Bhagwati 1997), when the articular surfaces of the lateral mass and pedicle of axis were made raw and a bone graft was [placed in this joint either bilaterally or unilaterally in rotational cases. Subsequently plate and screw over the joint or occipito cervical region was used (Goel - 1990, 1997, Bhagwati & Sankhla). Management of tuberculosis of cranio-cervical junction was presented in luncheon seminar of CNS meeting in 2004.

**Medulloblastoma:** A study of over 100 patients showed that prognosis is poor in patients less than 3 years of age, in those with large hydrocephalus needing a shunt insertion and in whom only partial excision is carried out. Those with total or near total excision and excision of almost 90% of the tumor do equally well and that there is no need to radically excise the tumor at the risk of brainstem damage (Bhagwati 2002, 2006). The role of adjuvant radiotherapy was found to be essential and additional chemotherapy was possibly helpful in prolonging life.

**Craniopharyngioma:** A total excision was the goal of surgery for craniopharyngioma. Gradually it dawned that total excision of a large, multiloculated, retrochiasmatic tumor often resulted in impairment of cognitive function, decreased attention span, poor scholastic performances, mental dullness, diabetes insipidus, hypothalamic disturbances, delayed growth, etc. The quality of life tended to be poor. It was also found that radiotherapy was quite effective and that subtotal excision with radiotherapy produced better results with improved quality of life. For nearly a decade now, this rational therapy is being offered, total excision being restricted for small tumors, tumors that are prechiasmatic and unicompartmental. Bhagwati (1992, 1992, 2004) started lamina terminalis approach.

**Gliomas:** For several years, Singhal and Bhagwati advocated a conservative wait and watch approach in the treatment of low grade gliomas that presented mainly with seizure disorder without signs of raised pressure. Radical excision is advocated when located either in frontal or temporal lobes. Most of the patients did not require surgical intervention for several years till tumor changed its morphology when it started growing in size, had increased seizure frequency and

signs of raised pressure. Knowing that surgery is not the answer for management of malignant gliomas, intratumoral instillation of autologous lymphocytes was carried out in patients with cystic gliomas- Bhagwati (1989). These cases showed regression of the symptoms initially but later on solid component continued to grow. A temporary remission of a few months was observed. Adoptive immunotherapy using lymphokine activated (LAK) killer cells was used for the management of malignant primary brain tumors with limited success, Sankhla and Bhagwati (1996).

**Subarachnoid Haemorrhage:** The incidence of subarachnoid hemorrhage was being reported as very low from all over the country except in Trivandrum. It was decided to study the Circle of Willis in J.J. Hospital, and 1024 cases were analyzed. These showed almost a similar number of anomalies of the Circle of Willis but only 2 aneurysms suggesting that overall low incidence of aneurysms was not only due to lack of recognition of the clinical entity but also due to its lower occurrence as seen in autopsy study (Deshpande and Bhagwati, 1993, 1998).

**Pediatric Neurosurgery:** Spinal dysraphism, the entity of tethered cord and its various causes were not recognized till pediatric neurosurgery took its roots after 1989. It formed an important topic of the symposium of ISPN (India) meeting in 1993 and subsequent various CME programmes arranged annually. Diastematomyelia, dermal sinus, dermoids, lipoma and tight filum terminale began to be recognized and treated thereafter (Bhagwati and Deopujari).

### **Multicentric Study in India in Neurosurgery**

1. 1992-1994. Cerebral shunt, developed by Shree Chitra Thirunal institute, Trivendrum. 7 centres participated and 150 cases studied.
2. 1994-1995. International Optic Nerve Trauma study conducted from Florida. Dr. A.K. Mahapatra (AIIMS) participated amongst the 32 centres in world and contributed 32 cases, the largest from a single centre.
3. 1999-2002. STICH study from England. Several centres from India participated in surgery for spontaneous intracerebral hemorrhage.
4. 2002-2004. CRASH I study, studying role of steroid in head injury by MRC 20000, patients from large number of countries participated. Over 20 centres participated from India.
5. 2003-2005. Role of factor VII in brain hemorrhage, a multinational study in which many centres from India participated.
6. 2004-2005. Ap 12009-G004 study on intratumoral TGF $\beta$  in recurrent high grade glioma. A FDA approved multinational German study, 150 patients enrolled and 7 centres participated from India.

7. 2005-2007. CRASH 2 study by MRC. Multiple centres participated from India.
8. I 131labelled monoclonal antibody in recurrent GBM, a FDA approved study. 5 centres are working in a multinational study.
9. FDG in GBM an Indian multicentric study by DRDO conducted in 7 centres in India.
10. International Infantile hydrocephalus study (HIIS). 25 centres participating to study the efficacy of shunt vs endoscopic 3<sup>rd</sup> ventriculostomy under 21 years. of age. AIIMS, and SGPGI participating.
11. IL-13 in recurrent GBM-FDA approved, multinational, multicentric study is going to start soon.
12. Ap 12009-G005. FDA approved multinational, multicentric German study on intratumoral TGF $\beta$  antagonist grade III glioma, 6 centers from India participated.

### **Books Published in the Field of Neurosurgery**

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2. Text Book of Spinal Surgery. Ramani P.S. (ed.) 1996, Mumbai.
3. Basic Manual for Management of Head and Spinal Cord injury. Ramani P.S., Mahapatra A.K. (eds.), 1996.
4. Neurosurgery of Complex Tumors and Vascular Lesions. Kobayashi S., Goel A., Hongo K (eds). Churchill Livingstone, New York / London, 1997.
5. Neurology in Tropics. Chopra J.S., Sawhney I.M.S. Churchill Livingstone, New Delhi 1999.
6. Brain Protection and Neurotrauma. Khosla V.K., Kak V.K., Sharma B.S.(ed), Narosa Publicaton, New Delhi, 2000.
7. Text Book of Head Injury. Mahapatra A.K., Kamal Raj (ed). MBD Publishers, New Delhi. 1999.
8. Text Book of Head Injury. Mahapatra A.K., Kamal Raj (ed). MBD Publishers, New Delhi, 2<sup>nd</sup> Edition, 2001.
9. Mental Health: An Indian Perspective (1946-2003). Agarwal S.P., Elsevier, New Delhi, 2004.



10. Text Book of Operative neurosurgery. Ramamurthy B., Sridhar K. (ed). B.I. Publishers, New Delhi, 2005.
11. Text Book of Head Injury. Mahapatra A.K., Kamal Raj. MBD Publishers, New Delhi, 3<sup>rd</sup> Edition, 2005.
12. Pediatric Neurosurgery – High Yield Database – Kumar Raj, Singh Vinita (ed) Paras Medical Publishers, Hyderabad. 2004.
13. Text Book “Brain Haemorrhage”. Mahapatra A.K., Chandra P. Sarat, Kumar Raj (eds). Jaypee Publishers, New Delhi- 2007.
14. Neurosurgery Reviews. Kumar Raj, Udit S., Mahapatra A.K. (ed). Jaypee Brothers, New Delhi, 2008.
15. Text Book, Cerebral Palsy Gyan Kosh. Purohit A.K., 2008.

### **Research Products Developed**

1. Hydrocephalus shunts
  - (i) Chhabra's shunt – from SGPGI marketed by Surgiwire Company, Saharanpur, U.P.
  - (ii) Ceredrain shunt from Sree Chitra Tirunal Institute, Thiruvananthapuram marketed by TTK Company.
2. Burr hole button, using hydroxyapatite by Sree Chitra Tirunal Institute of Medical Sciences (SCTIMST).
3. Indigenous fibrin glue by Sree Chitra Tirunal Institute of Medical Sciences (SCTIMST).
4. Artificial dura and ICP monitoring devices are under process of manufacturing - (SCTIMST).

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