The Role of Microsurgery in Neurosurgery

Iftikhar Ali Raja, Anjum Habib Vohra
Rizwan Masood Butt, Shahzad Shams
Department of Neurosurgery, King Edward Medical College,
Mayo and Lahore General Hospitals, Lahore - Pakistan.

Microsurgery is defined as a surgical technique performed with the help of an operating microscope. Advancements in the field of surgical technique have been an ongoing process. Operating with a normal eye has been a custom but the importance of magnification during a fine surgical procedure was soon realized and otologists were the first who stated using loupes during surgery. Loupes are an improvement over the naked eye but even when combined with a head light, they lack many of the advantages or a microscope. Loupes are available with provide upto 6.5 times magnification but magnification with loupes as it goes beyond 2.5 to 3 times, greatly restricts the operative field and the loupes become very heavy. The recent development of loupes with prisms have the advantage of providing a wider operating field.

Microsurgery enables the surgeon to carry out procedures not possible with the conventional techniques because of magnification and illumination. The microscope is essential for precision surgery of structures 3 mm or less in diameter. The magnification commonly used is 5 to 40 times although theoretically microsurgery is defined as surgery done with 3 to 40 times magnification provided by the operating microscope.

Historical Antecedents

General microscope was originally devised by Czapaski and developed by Zeiss during 1897 to 1899. Using magnification Evade[1], Maier and Lion[2] performed operation on labyrinthine of animals in 1921. The Otologists were the first to use the surgical microscope clinically in the treatment of middle ear disease. In 1921 Nylen[3] used a monocular microscope for operations on two patients, one suffering from chronic otitis media and the second from labyrinthine fistula. In 1946, the ophthalmic surgery with microscope is said to have been pioneered by Richard Troutman.

Jocobson[4,5,6] started the used of the microsurgery and reported in 1960 and 1962, the anastomosis of the small peripheral blood vessels, coronary endarterectomy, middle cerebral artery endarterectomy and ureteral reconstruction. In 1961 House[7] and Kurze[8,9] in 1962 reported the removal of an acoustic tumour with micro-dissection. In 1962, Smith[10] used the surgical microscope in peripheral nerve reconstruction. Donaghy[11] reported the use of microscope in the surgery of spinal cord and blood vessels. Kurze[8] in 1963 described his microsurgical techniques which he used for cordotomy, myelotomy cerebellopontine angle tumours, rhizotomy and extra-cranial nerve anastomosis.

The first successful reimplantation of an amputated digit using microvascular technique was performed by Komatus and Tamai in Nara, Japan in 1965. The organ transplant surgery was started much earlier. In 1950, Murray in Boston and Hamburger in Paris, each performed a renal transplant,. However the microsurgical techniques during organ transplant were started around 1965. In December 1967, Christian Barnard performed the first successful human cardiac transplant.

Adams and Witt[12], Pool and Colton[13], and Rand[14] have used the surgical microscope for operations on intracranial aneurysms for more than 21 years. The Donaghy and Yasargil's[11] operation in 1967 of anastomosis of the superficial temporal artery or occipital artery to a branch of middle cerebral artery for improvement of collateral circulation is another landmark in the development of microsurgical techniques. Ausman[15] and his associates performed extracranial/intracranial bypass surgery for the improvement in the vertebrobasilar circulation by connecting the occipital artery to the posterior inferior cerebellar artery and superficial temporal to superior cerebellar artery.

The peripheral nerve reconstruction has also been improved considerably by the techniques of cable grafting effectively developed by Samii[16]. The neurovascular decompression of the trigeminal and facial nerve for the treatment of trigeminal neuralgia and hemifacial spasm are now being successfully employed by the use of microsurgical techniques, although the Gardener[17,18,19,20] described it in 1950 and 1960.

The various companies have also developed a variety of microsurgical instruments. The microscope can be used with lasers, ultrasonic aspirator and bipolar coagulator. Microlaser[21]

systems have also been introduced in neurosurgery for the last 5 years. The CO_2, Nd-YAG and Argon type of lasers are used depending upon the type of surgical entity being treated. The allows a non touch technique for destroying tumour tissue and therefore reduces mechanical manipulation during resection of neoplasm like acoustic neuromas.

Advantages of Microsurgery

Microneurosurgery has opened new dimensions previously unattainable to neurosurgeons. It has improved the technical performance of many standard neurosurgical procedures; e.g, brain tumour removal, aneurysm surgery and even lumbar and cervical discectomies. It has improved operative results by permitting neural and vascular structures to be delineated with greater accuracy, deep areas of the brain to be reached with smaller cortical incisions and less brain retraction. The bleeding points can be coagulated with less damage to the adjacent neural structures, nerves distorted by the tumour can be preserved with greater frequency. and anastomosis of small vessels and nerves is possible.
Microneurosurgery has introduced a new era in surgical education by permitting the observation and recording by the attached VCR and still camera. This recording can be later used for study, discussion and education not only of the staff members but for the neurosurgeons around the world.

Microsurgery has made certain impossible procedures in neurosurgery possible.

Anastomosis of the extracranial to intracranial arteries, trassphenoidal extirpation of sellar tumours with preservation of pituitary gland, obliteration of previously inaccessible aneurysms, preservation of the facial and acoustic nerves in removal of acoustic tumours, complete and safe removal of the intramedullary spinal cord tumours, anastomosis of small nerves and vessels are some of the operations only possible by microscope.

Disadvantages of Microsurgery

The microsurgical techniques have certain handicaps.
1. Special training is needed.
2. Expensive set up and instrumentation is needed and their looking after is costly.
3. The operating time is prolonged but can be reduced with experience.
Long duration of operation can be:
a. Fatiguing
b. Increase the risk of infection.
Training in the use of microscope, microinstruments and microsuture is required, as is a shift away from tactile manual technique using fingers to the one relying on vision oriented instruments. The equipment is expensive and requires added space in the operating room and its care places and added burden on the nursing staff.
The surgeon must keep head, eyes and shoulders in a constant position for long periods, which is fatiguing and must maintain profound concentration. Distractions are poorly tolerated in operations under the microscope. It has been speculated that by prolonging some procedures, microoperative techniques may increase the risks of anesthesia and infection. By allowing operations to be done through smaller openings, however and by permitting increasing accuracy of dissection, they may reduce the duration of the procedure. Furthermore, any lengthening of the procedure by the use of microtechnique is progressively reduced as one gains experience.

Clinical Application of Microneurosurgery

These can be divided into four major group.
A Microsurgery of Brain Tumours.
B Microsurgery of Cranial and Peripheral nerves.
C Neurovascular surgery.
D Microsurgery of spinal Cord Diseases.

A Microsurgery of Brain Tumours

Surgical management of the brain tumours can be facilitated by a stereoscopic magnification of the surgical field and by excellent illumination, though the use of an operating microscope.

I Pituitary tumours

In the past transfrontal craniotomy was the most common surgical approach to the pituitary tumours but now through a transsphenoidal or transfrontal approach one can remove micro-adenomas, prolactinomas successfully, a procedure which could not be done without a microscope.

II Craniopharyngiomas

Complete resection of the craniopharyngiomas has now been made possible with the help of an operating microscope with much better surgical results.

III Cerebellopontine angle tumours

In the past saving of the facial nerve during

removal of rather big acoustic tumour was out of question, but now since the use of operating microscope the facial nerve can be preserved or its intracranial reconstruction can be performed. Success of the preservation of acoustic nerve has been only made possible through the use of the operating microscope.

IV Pinealomas

The removal of pinealomas was a real challenge and various approaches were developed for the removal of the tumours but it always remained a challenge till the introduction of the operating microscope after which the complete removal have become possible with much reduced mortality and morbidity.

V Other Tumours

Removal of the medially placed sphenoidal wing meningiomas, meningiomas of the lateral ventricle colloid cysts of 3rd ventricle, fourth ventricle ependymomas, tumour in the region of the Clivus and other deeply placed tumours can be completely removed with the help of operating microscope with minimum of operative morbidity and mortality.

B. Cranial and Peripheral Nerve Surgery

Complete removal of the intrapetrous facial neuromas and the tumour of the 5th, 9th, 10th & 11th nerves is now possible with the use of surgical microscope with a greater chance of preserving these nerves. The neurovascular decompression of trigeminal neuralgia and hemifacial spasm has now been firmly established after the use of the operating microscope.

Microsurgical technique applied during removal of tumours in the region of the optic nerves and chiasma have resulted i better preservation of the nerve and vision. Similarly the direct anastomosis of facial nerve in case it is divided and its cable grafting has already been discussed during the removal of acoustic tumours. Use of the operating microscope has led to faster and more complete recovery of the function after peripheral nerve reconstruction. Neurolysis is also facilitated with the use of microscope.

C Neurovascular Surgery

The dissection of cerebral aneurysm has been made safer and the preservation of perforating vessels arising from the circus of willis has been made possible with the use of surgical microscope.

The EC/IC bypass surgery for improving the cerebral and cerebellar circulation as mentioned above has been made possible only through the use of operating microscope as is small vessels anastomosis and ambolectomy of some of the cerebral vessels.

D Microsurgery of the Spinal Cord Disease

It is a common knowledge that since the use of micro-neurosurgical techniques in the treatment of meningiomas, neurofibromas, the post-operative neurological deficit has considerable decreased.

Complete removal of intramedullary lesion with an excellent post operative recovery has only been made possible after use of micro-surgical techniques.

The myelotomy can be accurate placed in an avascular area with the help of operating microscope and the plane of cleavage can be easily indentified.

Cordotomy and rhizotomy with the help of an operating microscope has shown better results.

Removal of cervical and lumbar discs is commonly performed in many centers with microscope.

Microneurosurgery in Pakistan

As far as we are aware the department of neurosurgery at Nishtar Hospital, Multan was the first to start microneurosurgery in 1985 regularly and successfully. Various other departments has also acquired the microscope and instruments and I am sure regular use of the microscopes will be a considerable help to the ailing human beings with much less mortality and morbidity.

Since then many operations for pituitary tumours, intraventricular tumours, acoustic tumours, tumours of the pineal region, brainstem tumours and various skull base tumours have been performed with the microscope.

Neurovascular decompression for hemifacial spasm and trigeminal neuralgia is now routinely performed.

EC/IC bypass surgery has been performed in Nishtar hospital and Lahore general hospital with varying degree of success.

The spinal cord tumours are now routinely operated with the help of the operating microscope with complete removal of intramedullary tumours and good results.

With the help of the operating microscope it is our feeling that we can save the nervous tissue during operations on myelomeningocoeles.

Microneurosurgery has come of age since 1961.

Microsurgical techniques has opened new horizons.

There is a need for re-evaluation of the surgical anatomy because the standard nervous system microscopic anatomy is not very helpful. However sufficient time has to be spent in the laboratory for learning the various techniques of microdissection and microanastomosis. The importance of microsurgery continues to increase as the neurosurgical residents under training have come to realize that training in microsurgery is essential for the proper care of their patients and development of their professional careers. Most of the neurosurgical training centers have established microsurgical laboratories.

By no means the final stage has reached on a subject as rapidly developing as microsurgery. It may be expected that increasing applications of microoperative techniques will open new avenues in neurosurgery.

References

1. Evald, J. Physiol. Untersuchungen and Endorgan d.N. Octav., Wiesbaden, 1892. Quoted in Nylen, C.O. The microscope in aural surgery, its first use and later developments, Actaotolaryngol. (suppl.) 116;226-240, 1954.
2. Maier, M., and Lion, H. Exper. Nachweis D. Endolymfbewegung. Arch. F.D, ges. Physiol. Berl. 187 : 47-74, 1921.
3. Nylen, C.O. The microscope in aural surgery, its first use and later developments, Acta Otolaryngol. (suppl) 116:226-240, 1954.
4. Jacobson, J.H.; Miller, D.B., and Suarez, E.L. Microvascular surgery : a new horizon in coronary artery surgery, Circulation 22 : 767, 1960/
5. Jocobson, J.H. II, and Suarez, E.L. Microsurgery in anastomosis of small vessels, surge. Forum 22 : 243-245, 1960.
6. Jacobson, J.H.II, and others : Microsurgery as an aid to middle cerebra artery endarterectomy, J. Neurosurgery. 19 : 108-115, 1962.
7. House, W.F. surgical exposure of the internal auditory canal and its contents through the middle cranial fossa, Laryngoscope 71; 1363-1385, 1961.
8. Kurze, T.L., Microtechniques in neurological surgery. In Shillito, J. Jr, and Mosberg, W.H., Jr. editors: Clinical neurosurgery, Baltimore, 1964, Williama & Wilkins.
9. Kurze, T., and Doule, J.B., Jr. Extradural entracranial (middle fossa) approach to the internal auditory canal, J. Neurosurg. 19 : 1033-1037, 1962.
10. Smith J. W., and Gillen, F.J. Current techniques in peripheral nerve repair. In Rand, R.W., editor. Microneurosurgery, ed. 2. St. Louis, 1978, The C.V. Mosby Co.
11. Donaghy, R.M.P. and Yasargil, M.G., Patch and by-pass in micro-angional surgery. Microvascular surgery, The C.V. Mosby Co. St. Louis, 1967.
12. Adams, J.E. and Witt, J. The use of the otologic microscope in the surgery of aneurysms, paper presented at the seventeenth annual meeting of the Neurological society of america, Litchfield Park, Ariz., January 1964.
13. Pool, J.L., and Colton, R.P. The dissecting microsope for intracranial vascular surgery, J. Neurosurg. 25 : 315-318, 1966.
14. Rand, R.W. Microneurosurgery in cerebral aneurysms. In Rand, R.W., editor. Microneurosurgery, ed. 2, St. Louis, 1984, The C.V. Mosby Co.
15. Ausman, J.I., and others. Microsurgery for atheroslerosis in the distal vertebral and basilar arteries. In Rand, R.W. editor. Microneurosurgery, ed. 3, St. Louis, 1984, The C.V. Mosby Co.
16. Samii, M. Microsurgery of some cranial nerves. In Rand, R.W. eidotor: microneurosurgery, ed. 3. St. Louis, 1984, The C.V. Mosby Co.
17. Gardner. W.J.,: The mechanism of tic dolorous. Trans. Am. Neroul. Assoc. 78 : 168-173, 1953.
18. Gardner, W.J.,: Concerning the mechanism of trigeminal neuralgia and hemifacial spasm J. Neurosurg 19 : 947-958, 1962.
19. Gardner, W.J.: Trigeminal Neuralgia, Clin, Neurosurg. 15 : 1-56, 1967.
20. Gardner, W.J., and Miklos, M.V. : Response of trigeminal neuralgia to decompression of sensory root; discussion of caue of trigeminal neuralgia, JAMA 170 : 1773-1776, 1959.
21. Hudgins, W., and Jacques, D.: The laser in microneurosurgry. In Rand. R.W. editor; Microneurosuregery, ed. 3. St. Louis, 1984. The C.V. Mosby Co.