SPECIAL ARTICLE
บทความพิเศษ

What's new in neurosurgery ?

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Introduction

On July 4th, 1997 the spacecraft Pathfinder successfully landed on Mars. The sojourner rover is now exploring the landscape of Mars and transmitting many pictures to earth. The difference between this landing and the landing of the Viking Lander in 1976 is the extensive public distribution of pictures and videoclips of the Martian landscape. Advances of computer technology in localization, navigation, and tracking are behind this success and the same process is used in frameless stereotaxy with a graphic interactive system. The computer age of space exploration began with the landing of the Viking Lander in 1976.[1] Twenty years ago, computer technology extended into many areas including neurosurgery. Last year, many new things occurred in the subspecialty of neurosurgery. This paper organizes the advances into 4 large groups: minimally invasive neurosurgery, gene therapy, Internet-world wide web, and neuroendovascular intervention.

Minimally Invasive Neurosurgery

1. Computer technology defining both structures and functions is an integral aspect of advances in biomedical imaging, Advanced digital processing improves the quality of the images. Three dimensional images are easily obtained from a CT scan or MRI.

Index Words: Internet, network, Parkinson's disease, brain tumor, gene therapy, molecular genetics, molecular neurosurgery, brachytherapy, interstitial irradiation, stereotaxy, computerized image processing, MRI, neurosurgical planning, three dimensional reconstruction.

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Improvements in imaging increase the accuracy of preoperative planning of target localization.

2. Frame-base stereotaxy is guided by a preoperative image. The position of an intended target within the image is transformed to a position within a frame and are system. The calculation of the position transformation may be done manually or by computer. Computer advances and the adaptation of digitizers to the operating room led to the utilization of frameless stereotaxy combined with a graphic interactive system. The development of a localization systems are step by step from mechanical arms to sound and light.[2] The approach to the destined target can be calculated by the process of localization, navigation, and tracking. These are the same processes used to send the Pathfinder to Mars.
3. **A miniature linear accelerator:** Cosgrove et al[3] reported the use of the photonic radiosurgical system (PRS) to treat 14 patients with primary and secondary tumors. Twelve patients had brain metastasis. PRS combined the short treatment time of external beam radiosurgery with the radiobiological advantages of interstitial brachytherapy. Its advantages are no requirement for special handling, no radioactive decay, and constant x-ray output. The PRS is a small x-ray generator that can be incorporated with stereotaxy to deliver a single fraction of high dose interstitial radiation. Its power source is from a 9.6 V rechargeable nickel-cadmium battery. Its role in the treatment of primary brain tumors is still unclear. It might be useful with small deep-seated gliomas or as intraoperative irradiation during open neurosurgical procedures. Further study is required.

Gene Therapy

1. Cell replacement and restorative gene therapy

Parkinson's disease[4]

- Cell replacement by grafting of embryonic dopaminergic (DA) cell implants[5-7], intrastriatal grafting of fibroblasts genetically modified to produce L-dopa[8], L-dopa-producing primary astrocytes[9], and brain derived neurotrophic factor (BDNF).[10]
- A defective herpes simplex virus (HSV)-1 vector expressing human tyrosine hydroxylase (TH) was used as a viral vector-mediated gene transfer to convert endogenous striatal cells into L-dopa-producing cells.[11]
- Direct injection of a plasmid-DNA-lipofectin complex into the striatum[12]

CNS injury[13]: Cationic liposomes are used as plasmid DNA carriers to transfect neurons for nerve growth factor (NGF) secreting and neurotrophic enhancement. Liposomes are classified as non-viral vectors. Synthetic carriers have more advantages than viral vectors.

2. Gene therapy of brain tumors

Suicide gene[4,14]: There are three prodrug-susceptibility genes which are known for experimental gene therapy of solid tumors in animals. They are the herpes simplex virus-thymidine kinase (HSV-tk), the Escherichia coli cytosine deaminase gene, and the E. coli guanine phosphoriosyltransferase gene. Retroviral-mediated HSV-tk/GCV therapy, in combination with surgery and radiation therapy, is being tested in clinical trials. Tumor cells transduced with the HSV-tk gene become sensitive to the antiherpes drug ganciclovir (GCV). Thymidine kinase phosphorylate GCV forms nucleotide-like precursors that will block replication of DNA.

Internet and Neurosurgery

Consisting of thousands of individual networks, the Internet is now the largest provider of information to people around the world. People with a modem and a telephone line can access the Internet with ease. The uses of Internet access in the medical profession are communicating with colleagues, searching current medical information, and obtaining programs or entertainment from international resources. Electronic communication can be done via electronic mail (E-mail), Internet Relay Chat, Internet based telephony systems, and videoconferencing systems. Neurosurgeons can search for interesting information through general search engine

providers, MEDLINE, and field specific sites.[15]

Information obtained via the world wide web (WWW) is composed of multimedia elements with graphic illustrations, video clips, and sound. Hypertext makes linkage to other sources of information possible by simple mouse clicking. Both multimedia and hypertext have made the WWW grow rapidly. There are many homepages related to neurosurgery and most of them belong to departments of neurosurgery at universities. Some webpages are electronic journals where neurosurgeons can read the details of previous abstract publications.[16-21] Further advances with JAVA language will make the WWW fully animated and interactive. Virtual Reality Modelling Language (VRML) turns 2 dimensional objects into 3 dimensional objects. A 3-D brain model can be created with VRML which will provide benefits in teaching, sending MRIs for consultation and other preoperative planning.

Neuroendovascular Intervention[22,23]

Neuroendovascular intervention has become an important alternative neurologic and neurosurgical treatment. This intervention requires the cooperation of a multidisciplinary team of neuroradiologists, neurosurgeons, and technicians. The major advance is from microcatheter intervention with superselective intravascular assessment and the advanced technology of digital subtraction angiography (DSA).

The microcatheters are the Tracker microcatheter of the USA and the Magic microcatheter of France.

DSA allows the refinement of routine catheterization and safe catheterization of high order vessels. Contrast media are now safer for use because of low osmolality and non-ionic media. Another advancement in computer software is real-time fluoroscopy or the roadmapping technique. Its usage:

1. Intracranial aneurysms: Currently it should be reserved for inoperable or high risk aneurysms, or performed as part of prospective comparisons of endovascular vs. surgical aneurysm exclusion. Giant intracranial aneurysms are one of the high risk lesions which can be treated by endovascular techniques. These techniques include parent artery occlusion, aneurysm trapping, endosaccular balloon occlusion, endosaccular coil occlusion and endovascular reconstruction by stent.
2. AVM: Embolization will be used as a preoperative adjucant to reduce the risk of surgery.
3. Dural arteriovenous fistula (DAVF)
4. Carotico-cavernous fistula (CCF)
5. Thrombolysis in the cerebrovascular system: tissue plasminogen activator (tPA)
6. Angioplasty
7. Brain tumors: decreasing the vascularity, decrease blood loss

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