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The Value of Neuronavigation in Deeply Seated Brain Lesions

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بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لاَ عْلَمَ لنَّا إِلاَّ مَّا عَلمْتُنَّا

إِنَّكَ أَنتُ الْعَلِيمُ الْحَكِيمُ

صدق الله العظيم

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This work is dedicated to:

All my family

and

My Wife

Contents

List of abbreviation

AVM	: **Arteriovenous malformation**
CT	**: Computerized tomography**
DTI	: **Diffusion tensor imaging**
fMRI	: **Functional magnetic resonance imaging**
IOUS	**: Intraoperative ultrasonography**
LEDs	: **Light emitting diodes**
MRI	: **Magnetic Resonance Imaging**
SPECT	: **Single photon emission computed tomography**

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Abstract

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Aim of work

Abstract

Neuronavigation provides intraoperative orientation to the surgeon, helps in planning a precise surgical approach to the targetted lesion and defines the surrounding neurovascular structures. Incorporation of the functional data provided by functional MRI with neuronavigation helps to avoid the eloquent areas of the brain during surgery. An intraoperative MRI enables radical resection of the lesions, the possibility of immediate control for tumor remnants and updates of neuronavigation with interaoperative images to compensate for brain shift.

Keywords

Neuronavigation, functional MRI, stereotaxy, brain lab, deeply seated brain lesions

The Value of Neuronavigation in Deeply Seated Brain Lesions

Image-guided neurosurgery (Neuronavigation) or frameless stereotactic surgery has made a tremendous impact over the past few years. It provides a patient-specific three-dimensional (3-D) anatomy for preoperative planning and Intraoperative navigation thus helping the surgeon to perform complicated procedures with accuracy and safety **(Tasker, 1996).**

Exact targeting of small brain lesions, even in subcortical and deeply located brain areas, is still a challenge to neurosurgeons. Information from two-dimensional images must be transferred to the three dimensional spaces of the brain. With the development of detailed imaging techniques, stereotactic neurosurgery is now widely used for the treatment of small and deeply located pathological lesions in the brain **(Mclnerney and Roberts, 2000).**

The application of Neuronavigation to the surgical resection of brain tumors provides information that allows the use of minimal craniotomies, accurately localizes subcortical lesions, and may assist in determining lesion boundaries **(Hassenbusch et al., 1991).**

The principle of interactive image-guided neurosurgery is to keep the imaging data as long as possible in its original digital format by transferring it to a computer workstation dedicated to the operating room and allowing a direct interaction with the data. With the help of the computer and an intraoperative position, sensing system-reconstructed image can be presented allowing for accurate, dynamic, and interactive, three-dimensional localization of surgical targets and trajectories **(Koivukangas et al., 1999)**.

The challenges presented to the neurosurgeon especially glial neoplasms include their often deep-seated location within eloquent parenchyma, their irregularly shaped outlines, and their ill-defined margins due to parenchymal invasion. The neuronavigation system proved to be very helpful at many stages of these operations **(Maciunas et al., 2002).**

Aim of the work

1. To evaluate the advantage and disadvantage of neuronavigation system.
2. To study the efficacy and limitations of neuronavigation in the surgery of intracranial lesions.

Chapter one

Introduction

Introduction

Imagine for a moment, if you will, that you are the pilot of one of those early propeller-powered airplanes flying over the South American Andes without all the modern navigation instruments, and you encounter worsening weather conditions ending up in totally non-transparent fog. Visual orientation neither allows for continuation of your journey nor for even partly secure emergency landing because of missing landmarks that could help you to find an appropriate area.

Neurosurgeons once in a while end up in such a situation while trying to find particularly small lesions in the depth of the brain or to resect a complex brain tumor. Intracranial localization is a major challenge in neurosurgery and a precise sense of complex three-dimensional anatomic relationships has to be maintained in order to successfully perform any operation ***(Maciunas, 1993)***. The art of surgical navigation has traditionally been taught in such a way that specific landmarks had to be identified that could then be used as touchstones during operations. Venturing deeper into subcortical parenchyma has demanded from the neurosurgeon distinctive skill, judgment, experience and apprenticeship ***(Maciunas 1999)***.

Navigation instruments found their place in modern aircraft many decades ago. Pilots don't have to trust any more only their own memory and printed maps that do not include any actual weather information. Radar, continous weather monitoring and satellite-based navigation update computerized maps in real-time. In