بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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جامعة عين شمس

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Comparative Study between Neuro-navigation and Intra-Operative Ultrasound in Excision of Intra-axial Brain Lesions

Thesis

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In Neurosurgery

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List of abbreviations

AA	anaplastic astrocytoma
AIDS	Acquired Immune Deficiency Syndrome
CBV	cerebral blood volume
Ch	choline
CNS	central nervous system
CSF	cerebrospinal fluid
DTI	diffusion tensor imaging (on MRI)
DWI	diffusion-weighted images (on MRI)
EBV	Epstein Barr Virus
FDG	FluoroDeoxyGlucose
EOR	extent of resection
fMRI	functional magnetic resonance imaging
GBM	glioblastoma multiforme
GTR	gross total resection
HGG	high-grade glioma
ICH	intracerebral hemorrhage
ICU	intensive care unit
iMRI	intraoperative magnetic resonance IMAGE
IOUS	intraoperative ultrasonography
JPEG	Joint Photographic Experts Group
LGG	low grade glioma
MRS	magnetic resonance spectroscopy

NAA	N-acetyl aspartate
NTR	near total resection
OTS	Optic Tracking Device
PCNSL	Primary CNS lymphomas
PET	Positron Emission Tomography
STR	subtotal resection
T1WI	T1-weighted image (on MRI)
T2WI	T2-weighted image (on MRI)
UNIX	Uniplexed Information and Computing Service
US	Ultrasound
WHO	World Health Organization
3D US	3-dimensional ultrasound

INTRODUCTION

Interactive image-guided neurosurgery for the resection of brain tumors was developed within the last 10 years at different neurosurgical centers around the world to improve the safety of the surgery and the functional outcome of the patients ***(Chernove et al., 2005).***

Neuro-navigation is useful in providing orientation to the surgeon with sufficient application accuracy. It facilitates a precise planning of the surgical vector to target small, subcortical lesions ***(Peter et al., 2006).***

The term neuro-navigation is neologism used to describe the set of computer assisted technologies used by neuro-surgeons to guide "navigate" within the confines of the skull during surgery ***(Garslandt et al., 2002).***

Ultrasound is a very interesting alternative for intra-operative imaging. In recent years ultrasound has gone through considerable technical development ***(Solheim et al., 2010).***

Ultrasound is an excellent modality for scanning intracranial structures once the calvarium has been opened ***(Unsgaard et al., 2006).***

Real time intra-operative ultrasound is obviously a useful adjunctive instrument during neuro-surgical

procedures using an appropriate transducer with an adequate frequency, depth and location of the lesion can be confirmed within minutes before opening of the dura matter ***(Sun and Zhoo, 2007).***

Intra-operative ultrasound is effective not only for differentiating the lesion from the normal brain, but also for determining consistency. Calcified or cystic lesion are specially well demonstrated due to their unique hyper - and hypo echogenicities ***(Dahrmann and Rubin, 2001).***

The intra-operative ultrasound is very useful in intra-operative localization and delineation of lesion and planning various stages of tumors resection available ***(Renner et al., 2005).***

The clinical trails proved that the employed neuro-navigation system is versatile, safe and that there is no adverse effects, complication or surgical mortality due to the devise. It enables the surgeon to plan smaller sized and better centered skin incisions and craniotomies and to approach the targeted lesions with less dissection of the intact brain tissue. Despite more radical removal of lesions the overall invasiveness of the operation was decreased, and the surgeons feeling of safety could be improved ***(Gumprecht et al., 2005).***

Since its initial use, numerous studies have demonstrated the efficacy of intra-operative ultrasound in localizing the lesion specially for metastases and high grade glioma is good ***(Venelin et al., 2011).***

Even low grade gliomas, intra-operative ultrasound is better able to demarcate the hyper-echoic tumor which may be difficult to localize with the naked eye at surgery ***(Wong et al., 2011).***

Aim of the Work

The aim of this work is to compare the results of using neuro-navigation and intra-operative ultrasound in excision intra-axial brain lesions concerning:

- Localization.
- Degree of surgical excision.
- Outcome.

PATHOPHYSIOLOGY

Intra-axial is a term that denotes lesions that are within the brain parenchyma, in contrast to extra-axial, which describes lesions outside the brain, and intra-ventricular, which denotes lesions within the ventricular system. Some authors include intra-ventricular lesions in the intra-axial group as most are lesions that arise from the brain parenchyma and grow exophytically into the ventricular system.

Examples of intra-axial lesions include:

- Neoplasm
  - Primary
    - Glioblastoma (GBM)
    - Astrocytoma
    - Primary CNS lymphoma
    - Ganglioglioma
    - Oligodendroglioma
  - Cerebral metastases
- Infection
  - Cerebral Abscess
  - Neurocysticercosis
- Intracerebral hemorrhage (ICH)

(Ostrom et al., 2012)

Astrocytic tumors

Astrocytic tumors are primary central nervous system tumors that either arise from astrocytes or appear similar to astrocytes on histology having arisen from precursor cells. They are the most common tumors arising from glial cells.

They can be divided into those that are diffuse in growth (the vast majority, generally having higher grade and poorer prognosis) and those that are localized (tend to have a lower grade and better prognosis) ***(Aiello and Alter, 2016).***

Diffuse

- Diffuse astrocytoma: WHO grade II (10-15% of astrocytomas)
- Anaplastic astrocytoma: WHO grade III (25% of astrocytomas)
- Glioblastoma: WHO grade IV (50-60% of astrocytomas)

Localized

- Pilocytic Astrocytoma: WHO grade I
- Subependymal Giant Cell Astrocytoma: WHO grade I
- Pilomyxoid Astrocytoma: ~WHO grade II
- Pleomorphic Xanthoastrocytoma: WHO grade II

Additionally, some tumours also contain astrocytic components, and it is often this component that dictated biological behaviour. Examples include:

- Ganglioglioma
- Oligoastrocytoma ***(Buckner et al., 2007)***

Glioblastoma

Epidemiology

A glioblastoma may occur at any age; however, they usually occur after the age of 40 years with a peak incidence between 65 and 75 years of age. There is a slight male preponderance with a 3:2 M: F ratio . Caucasians are affected more frequently than other ethnicities: Europe and North America 3-4 per 100,000 whereas Asia 0.59 per 100,000 ***(Katharine, 2016).***

Clinical presentation

Typically patients present in one of three ways:

- Focal neurological deficit
- Symptoms of increased intracranial pressure
- Seizures

Rarely (<2%) intratumoral hemorrhage occurs and patients may present acutely with stroke-like symptoms and signs.

Pathology

Although glioblastomas can arise anywhere within the brain, they have a predilection for the subcortical white matter and deep grey matter of the cerebral hemispheres, particularly the temporal lobe.

Cellular variants

Glioblastomas are capable of demonstrating varied patterns, sometimes within the one tumor. In addition to the three recognized variants (giant cell glioblastoma, gliosarcoma and epithelioid glioblastoma) additional histological features are sometimes encountered which impact on imaging appearance and biological behavior. Most of these are seen predominantly in primary IDH wild-type glioblastomas. (Alexander et al., 2017).

These include:

Gametocytes

Granular cells

Lipidized cells

Oligodendroglioma component

Primitive neuronal cells

Small cell glioblastoma

(Alifieris and Trafalis, 2015).

Radiographic features

Glioblastomas are typically large tumors at diagnosis. They often have thick, irregular-enhancing margins and a central necrotic core, which may also have a hemorrhagic component. They are surrounded by vasogenic-type oedema, which in fact usually contains infiltration by neoplastic cells.

Multifocal disease, which is found in ~20% of cases, is that where multiple areas of enhancement are connected to each other by abnormal white matter signal, which represents microscopic spread to tumour cells. Multicentric disease, on the other hand, is where no such connection can be seen ***(Clarke et al., 2012).***

CT

- Irregular thick margins: iso to slightly hyperattenuating (high cellularity)
- Irregular hypodense centre representing necrosis
- Marked mass effect
- Surrounding vasogenic oedema
- Hemorhage is occasionally seen
- Calcification is uncommon**):**
- Intense irregular, heterogeneous enhancement of the margins is almost always present ***(Alexander et al., 2017).***