THE VALUE OF THE LASER IN THE OPERATIVE MANAGEMENT OF THE CENTRAL NERVOS SYSTEM TUMORS

Thesis

Submitted for partial fulfilment of M.D. in Neurosurgery

By

Magdy Abd Elazim Mohamed Osman

M.B.B. Ch., M. S. General Surgery

Supervisors

Professor Dr. Ahmed El Benhawy

Prof. of Neurosurgery

Ain Shams University - Cairo - Egypt

Professor Dr. Hassanin Al Sharif

Prof. and Chairman of Neurosurgery Department

Ain Shams University - Cairo - Egypt

Professor. Dr. John. M. Tew, Jr. M.D.

Prof and Chairman of Neurosurgery Department.

Cincinnati - Ohio - USA

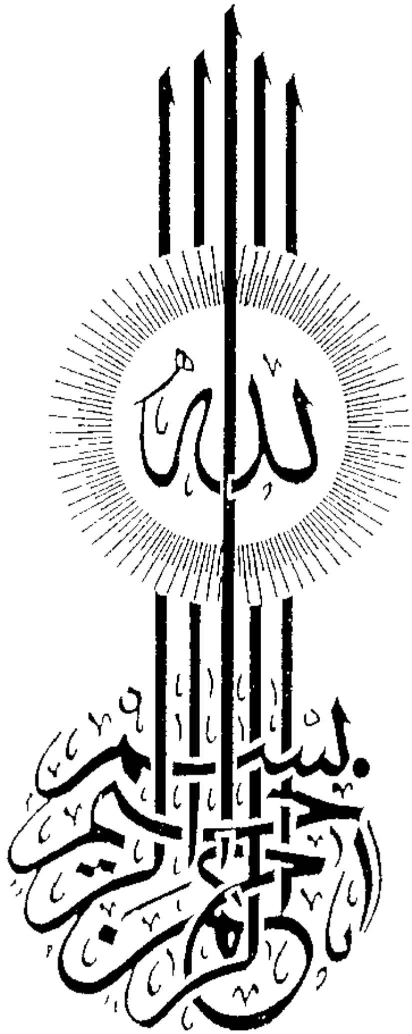
Ain Shams University

1990

D E D I C A T I O N

I DEDICATE THIS WORK FOR THE LATE

PROFESSOR Dr. EL BANHAWY


بسم الله الرحمن الرحيم

بسم الله الرحمن الرحيم

D E D I C A T I O N

I DEDICATE THIS WORK FOR THE LATE

PROFESSOR Dr. EL BANHAWY

A C K N O W L E D G E M E N T

I would like to express my great and continuous gratitude to the late profesor Dr. El Banhawy and asking the God to harbour him his paradis. He was one of my supervisors, he was responsible to give me the chance to go abroad.

I would like also to express my sincere thanks and gratitude to profesor Dr. Hassanin Al Sharif for his help, support and his continuous guidence by updated informations in that feild.

I am also very thankful and grateful to professor Dr. Tew for his generous scientific hospitality, that had been given to me in his department.

I would like also to express my deep appreciation and gratitude to professor Dr. Sawaya for his support, enthusiastic guidence, innovation and constructive criticism.

I would like also to thank professor Dr. Vanlovern, and professor Dr. Hakim for their help and support.

I am also endected to every staff member in both Ain Shams and Cincinnati Universities for their help, and support and valuable advices.

CONTENTS

INTRODUCTION
AND
AIM OF THE WORK

INTRODUCTION AND AIM OF THE WORK

Laser is an acronym for "Light Amplification by Stimulated Emission of Radiation".

There are three types of laser currently used in clinical practice in neurosurgery. They are carbon dioxid laser (CO2), neodymium yttrium-aluminum garnet (Nd:YAG) and argon laser.

The CO2 laser is the primary laser used in neurosurgery. It produces a precise incision with minimal lateral necrosis, beside its ability to vaporize the tissue.

The Nd:YAG is a good coagulator even at the sites of active bleeding. It has sufficient power to incise and vaporize the tissue but, in doing so, causes more damage to the adjacent healthy tissue (SANKAR, 1987). So, the main use of it in neurosurgery as adjunctive tool to achieve good hemostasis or to excise vascular masses.

The argon laser is of limited use in neurosurgery, it is mainly absorbed by tissue pigments such as hemoglobin and melanin. For this reason, argon laser mainly used in the fields of ophthalmology and dermatology.

One of the goal of this thesis was to transfer the updated technology of the uses of laser in neurosurgery. For this reason, I emphasized in details, reaching to the limit of the exageration, all what written about the usage of laser in neurosurgery in the review of this thesis.

Finally, the mention of the term "laser" often elicits a sensation of magic, and laser surgery is expected by many professionals as well as lay personnel to provide a panacea for all of the previously unsolved challanges facing clinicians today. This thesis, therefore, has also undertaken the goal of providing a realistic look at lasers and the benefits they have provided, the limitations of their application, and possible further technical advances that may diminish or eliminate these limitations.

THE AIM OF THE WORK

The aim of the work done on this thesis to evaluate the benefit of laser microsurgery in the surgical removal of the lesions of the third ventricular regions, and 52 patients harbouring varying pathology in the third ventricular region treated surgically using CO2 and Nd:YAG lasers are reviewed and their results are analysed.

REVIEW OF LITERATURE

HISTORY OF LASER

Laser is an acronym for "Light Amplification by Stimulated Emission of Radiation." Einstein's study in 1917 entitled "Zur Quantum Theori der Strahlung" outlined the principles for the stimulated emission of photons (Einstein, 1917). This paper provided the theoretical basis for laser physics. Basov and Prokhorov, in 1954, further detailed the process of amplification of stimulated emission (Hecht and Teresi, 1982).

In 1958, Schawlow and Townes published "Infrared and Optical Masers", which outlined the structure and design of an apparatus for producing laser light (Schawlow and Townes, 1958). Theodore Maiman actually produced the first laser light in 1960 using a ruby crystal as the active medium (Maiman, 1960). The development and growth of the laser industry which has revolutionized business, science, industry, and the military evolved from these unique accomplishments.

Shortly after the development of the first laser, initial biomedical experiments utilized the millisecond pulsed ruby laser to detect the effects of laser radiation on skin, retinal tissue, and experimental tumors.

The first series of publications concerning laser effects on biological tissues aroused the interest of medical scientists. Unrealistic hopes of new ways to treat cancer with lasers stimulated interest in the possibility of dramatic cures.

The first articles that explored the impact of laser lesions upon central nervous system tissues appeared in the mid 1960s.

High-powered pulsed ruby laser lesions aimed at the brains of experimental animals, through intact skulls, caused severe mechanical recoil of the brain and resulted in death due to cerebral contusion, subarachnoid hemorrhage, and herniation. It was postulated that this mechanical recoil of the brain occurred as a result of sudden tissue vaporization and rapid volume expansion and herniation of cerebral contents. Lesions made by direct exposure of the brain caused only local cerebral hemorrhage and necrosis.

Rosomoff and Carroll reported the use of the ruby laser in three human patients with glioblastoma in 1966 (Rosomoff and Carroll, 1966). Low-powered pulses of laser radiation were applied to the tumor. Histological study of tissues from two of the patients that subsequently underwent post-mortem examination confirmed the laser caused nonhemorrhagic necrosis of the tumor, which had been directly exposed to laser light. Further studies of the central nervous system tissue effects of laser radiation showed that neural tissue injury was irreversible and that neurons were more susceptible to the effects of this laser than astrocytes. Myelinated fibers were more resistant than unmyelinated fibers to laser radiation. Laser-induced injury could be confined to the site of impact without distant brain injury.

Attention was turned to the more powerful continuous mode carbon dioxide laser, developed by Patel in 1964 (Patel, 1968). Reports of the tissue effects of carbon dioxide laser followed soon after. This new surgical "light knife" was reported to be very efficient at incising tissues cleanly, rapidly, and bloodlessly. However, it was unable to coagulate blood vessels measuring more than 1 mm in diameter.

Stellar made many contributions to the field of laser surgery (Stellar et al, 1970). He defined the characteristic histological changes that occur with carbon dioxide laser lesions in neural tissues; recognized the ability of laser energy to vaporize large masses of tissues; demonstrated that bloodless removal of transplantable mouse ependymablastomas and melanomas was possible; reported the production of precise lesions in the brain and spinal cord of experimental animals; and suggested neurophysiological investigations and possible therapeutic modifications of neurological function such as pain perception in human patients. He applied the carbon dioxide laser to malignant gliomas in three patients in 1969 and found that hemorrhage associated with extirpation was reduced, but that larger vessels could not be controlled with the laser (Stellar, 1980). No local systemic or adverse late affects were associated with the use of the carbon dioxide laser in these patients.

The evolution of laser neurosurgery came to a near standstill in the early 1970's because benefits for use in clinical neurological surgery could not be defined. Moreover, the laser apparatus was cumbersome to use in the operating room, and adjunctive equipment necessary for application to microscopic equipment was unavailable. Interest in laser microsurgery was rekindled by Heppner and Ascher in Austria (Heppner and Ascher, 1976) and Takeuchi (Takeuchi et al, 1982) and Takizawa (1978) in Japan in the mid-1970's. They and others have documented indications and benefits for the laser in neurological surgery. Reports of clinical and experimental applications of lasers are frequently found in the literature.