



شبكة المعلومات الجامعية  
التوثيق الإلكتروني والميكروفيلم

# بسم الله الرحمن الرحيم



**MONA MAGHRABY**



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# جامعة عين شمس التوثيق الإلكتروني والميكروفيلم

## قسم

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**MONA MAGHRABY**

# **Gamma Knife Radiosurgery role in the management of brain stem cavernous angiomas.**

*A THESIS Submitted for partial fulfilment of the conditions for the award of  
a Medical Doctorate (MD) Degree in Neurosurgery.*

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## List of abbreviations

<b>ARE</b>	<b>Adverse Radiation Effects</b>
<b>AVM</b>	<b>arteriovenous malformation</b>
<b>APS</b>	<b>automated positioning system</b>
<b>BSCM</b>	<b>Brain Stem cavernous malformation</b>
<b>BSCA</b>	<b>Brain Stem Cerebral Angioma</b>
<b>CNS</b>	<b>Central Nervous system</b>
<b>CCA</b>	<b>Cerebral Cavernous Angioma</b>
<b>CCM</b>	<b>cerebral cavernous malformation</b>
<b>CT</b>	<b>Computed tomography</b>
<b>CBCT</b>	<b>cone-beam CT</b>
<b>DVA</b>	<b>developmental venous anomaly</b>
<b>FNDs</b>	<b>focal neurologic deficits</b>
<b>GKR</b>	<b>Gamma knife Radiosurgery</b>
<b>GRE</b>	<b>gradient-echo</b>
<b>H&amp;E</b>	<b>Hematoxylin and eosin</b>
<b>HD</b>	<b>High Definition</b>
<b>ICH</b>	<b>Intra Cerebral Hemorrhage</b>
<b>LGK</b>	<b>Leksell Gamma Knife</b>
<b>LGK-PFX</b>	<b>Leksell Gamma Knife PERFEXION</b>
<b>LINAC</b>	<b>Linear accelerator</b>
<b>MRI</b>	<b>Magnetic Resonance Imaging</b>
<b>MD</b>	<b>Marginal Dose</b>
<b>mJ</b>	<b>milliJoules</b>
<b>% isodose</b>	<b>Prescription Isodose</b>
<b>3D</b>	<b>three-dimensional</b>
<b>TV</b>	<b>Treated Volume</b>

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# I-INTRODUCTION

Cavernous malformations are vascular lesions composed of thin walled, dilated capillary spaces with no intervening brain tissue. Other terms used for cavernous malformations include cerebral cavernous malformation (CCM), cavernous angioma, and cavernous hemangioma. The most common term is cavernoma (**Krings et al, 2016**).

Cavernous angioma is a benign vascular malformation, which can be found at any region within the brain. Cavernous angioma accounts for 5%–15% of all central nervous system vascular malformations (**Wanke I, et al., 2015**). Brain stem cavernous angioma is rare, affecting only 0.4%–0.9% of the population and representing 9%–35% of intracranial cavernomas. Brain stem cavernous angioma is most frequently found in the pons (**Kim et al, 2014**).

Cavernous angioma can be either familial or sporadic. The familial form of the disease often manifests as multiple lesions in the setting of a family history of neurological disease. In the sporadic form, patients rarely have more than two lesions, and family history is typically absent (**Nicholas-Bublick S et al., 2012**). Mutations in three genes, CCM1, CCM2, and CCM3, have been discovered as being responsible for the familial disease, accounting for 96% of all mutations (**Ellenbogen et al., 2012**).

Most lesions are asymptomatic, being discovered incidentally, if ever. Only 20% to 30% of cerebral cavernous angioma patients will be symptomatic in their lifetimes, presenting to medical attention most commonly during their third to fifth decades of life with symptoms such as headaches, seizures, and focal neurological deficits due to lesion expansion following such events as thrombosis and hemorrhages (**Pandey P et al., 2013**).

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The most serious complication of cavernous angioma is intracerebral hemorrhage. Patients with posterior fossa cavernous angiomas are reported to be 6.75 times more likely to present with a bleed and the rehemorrhage rate is higher than that for lesions in other locations. Not only were these repeat hemorrhages common but brainstem cavernous angiomas can result in debilitating deficits due to the high density of critical tracts and nuclei in this region (**Gorgan R et al.,2016**). The annual hemorrhagic rate of brainstem cavernous angiomas has been estimated at 0.1%–2.5% per lesion per year and 0.25%–16.5% per patient per year, but this rate obviously increases (up to 34% the annual risk) in patients with prior hemorrhagic events (**LI et al., 2014**).

The current treatment of choice for most symptomatic cavernous angioma is microsurgical resection; however, morbidity and mortality associated with the operation are especially high in surgically inaccessible lesions such as brain stem. Therefore, radiosurgery has been used as an alternative method of treatment and the primary goal of the radiosurgery is the prevention of repeated haemorrhage. Though the natural history of brainstem cavernoma and the use of radiosurgery in the management are still controversial issues recent studies reported reduction of recurrent haemorrhage after radiosurgery. Medical management is limited to seizure control and symptomatic relief of headaches (**Brehar et al., 2016**). For brainstem cavernous angioma, the goal of any treatment method is to control rebleeding and avoid complications from recurrence (**Yilmaz T et al., 2015**).



## **II- AIM OF WORK:**

Our study aimed to evaluate the efficacy, and safety of Gamma Knife radiosurgery in the management of brainstem cavernous angiomas.

## III- Literature Review

### Neuroanatomy of brain stem

#### Introduction

The brainstem lies upon the basal portion of the occipital bone (clivus) and is connected to, and largely covered by, the cerebellum. Caudally, the medulla is continuous with the spinal cord just below the foramen magnum. Rostrally, the midbrain is continuous with the diencephalon of the forebrain (Stephen G. et al., 2010).

The brainstem consists of the medulla oblongata, pons and midbrain. The archaic term ‘bulb’ is applied to the brainstem in compound anatomical names given to nerve fibres originating from, or terminating in, the brainstem (e.g. ‘corticobulbar’ refers to axons that arise in the cerebral cortex and terminate in the brainstem). It is also used clinically to denote the medulla in such terms as ‘bulbar palsy’ and ‘pseudobulbar palsy’, which describe syndromes associated with medullary dysfunction (Crossman A. et al., 2020).

The brainstem contains numerous ascending and descending fiber tracts. Some of these pass throughout its whole length, having their origin in the spinal cord or cerebral hemisphere, respectively; others have their origin or termination within brainstem nuclei. Certain of these brainstem nuclei receive fibres from, or send fibres into, cranial nerves, 10 pairs of which (III–XII) attach to the surface of the brainstem. These are known as the **cranial nerve nuclei**. In addition, the brainstem contains a complex and