The Role of Gamma Knife Radiosurgery in Treatment of Brain Lesions (A Statistical Study for the First 1059 Patients Treated by Gamma Knife Radiosurgery in Neuroscience Hospital in Iraq)

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ABSTRACT:

BACKGROUND:

Statistical study for the first 1059 patients treated by Gamma knife radiosurgery in IRAQ, in neuroscience hospital

OBJECTIVE:

Gamma knife surgery is a minimally invasive technique indicated for the treatment of different brain lesions with Cobalt60

PATIENTS AND METHODS:

A retrospective study was conducted on a total of 1059 consecutive patients who underwent 1039 sessions of GKS procedures using perfexion model , at the neuroscience hospital between January 2016 and July 2017

RESULTS:

There were 568 males and 432 females. The mean age was 33.2 years , all patients were treated with gamma knife radiosurgery. The indications included brain tumors, vascular malformations & neuromodulation therapy for (epilepsy & trigeminal neuralgia).

CONCLUSION:

Gamma knife management is an effective, minimally invasive with minimal side effects.

Gamma Knife is indicated for the treatment of brain lesions & functional neuromodulations for pain and epilepsy.

KEYWORDS: Gamma Knife, Radiosurgery, Functional Neurosurgery

INTRODUCTION:

The gamma knife is a complex machine that uses cobalt 60 as its energy source, and is able to focus a precise intersection of beams of gamma rays to perform radiosurgery [1]. The target is clearly defined through the use of high-resolution CT and MRI scans coupled with computer technology. GKS is a minimally invasive technique [2,3,4,5]. Gamma Knife provides a very steep radiation dose fall-off. The irradiation hits the pathological cells with a locally-high concentration of energy while at the same time the neighboring areas of the brain are spared from being affected by the irradiation.

This specific gradient of radiation in all three dimensions guarantees that the surrounding brain tissue is only minimally exposed to the radiation and is thereby “protected” against undesired radiation effects [2,6,7]. Currently, Gamma Knife is used primarily to inactivate benign brain tumors (acoustic neuromas, meningiomas, pituitary adenomas, craniopharyngiomas, and other tumors of the skull base and brain); malignant tumors; pain conditions such as trigeminal neuralgia; movement disorders such as tremor; and treatment-resistant epilepsy. Gamma Knife radiosurgery is a preferred option for many patients with cancer that has spread (metastasized) to the brain. For certain patients with deep-seated tumors or AVMs, the Gamma Knife may be preferable to conventional surgery.

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Because the unit can tailor radiosurgical doses to lesions of suitable size, it is used as an alternative microsurgical or endovascular embolization in these patients[5,7,8,9]. With Gamma Knife, there is no scalpel, no general anesthesia and no hospital stay [10]. Patients usually wear street clothes during their treatments and return to their normal activities when their treatments have been completed [11,12,13].

In addition to their clinical uses, the Gamma Knife units are the focus of various research efforts to enhance our understanding of its radiobiologic effects and to identify new uses for the technology [1,13.14,15].

PATIENTS AND METHODS:

A retrospective study was conducted on a total of 1059 consecutive patients who underwent 1039 sessions of GKS procedures using perfexion model, at the neuroscience hospital between January 2016 and July 2017.

The indicated pathologies that treated during this period are

- ✓ Brain Metastases
- ✓ Vestibular Schwannoma (Acoustic Neurinoma)
- ✓ Meningioma
- ✓ Glioma and other rarer brain tumors
- ✓ Pituitary Adenoma
- ✓ Arterio-venous malformations (AVM)
- ✓ Trigeminal Neuralgia
- ✓ Functional Indications

Following are the steps in radiosurgery with the Gamma Knife Perfexion:

1. Daily quality assurance of the radiosurgical facility.
2. Stereotactic frame placement.
3. Frame adaptor and frame cap fitting check.
4. Stereotactic brain imaging with magnetic resonance imaging (MRI), computed tomography (CT), angiography, or any combination of these modalities.
5. Coregistration of neurological images and importation to radiosurgical software.
6. Treatment planning.
7. Dose prescription.
8. Dose limitations to critical structures: shielding and plugging technique.
9. Conformal radiosurgical dose planning by the radiosurgery team.
10. Stereotactic delivery of radiation to the target volume by positioning of the patient's head inside a collimator system.
11. Removal of the stereotactic guiding device.

Follow-up imaging and clinical evaluations

Following GKS, the patients were initially followed clinically at interval of 3–6 months, then annually or biennially thereafter. Meanwhile, they were followed radiologically with MRI or CT every 6 months for the first 2 years, then yearly.

RESULTS:

There were 568 (56.8%) male and 432 (43.2%) female patients. The mean age was 33.2 years (median 36; range 4–78 years).

Table 1: Age distribution

Age	Years
Median	33
Mean	33.2
range	4-78 Y

Table 2: gender distribution

Gender	Number	%
Male	568	56.8 %
Female	432	43.2 %

Table 3: general classification types of pathology & no. of cases

Tumors	Vascular (AVM)	functional	total
768	102	189	1059
a- tumor		No. of cases	
Meningioma		240	
Neurofibroma		149	
Gliomas		148	
Pituitary adenomas		121	
Brain secondaries		65	
Pinealomas		15	
Craniopharyngiomas		14	
Others*		13	
Nasopharyngeal ca.		3	
Total		768	
b-vascular		No. of cases	
AVM		102	
c-functional		No. of cases	
Trigeminal neuralgia		183	
Mesial temporal sclerosis		6	

*(glomus tu., chordoma, medulloblastoma, papillomas, lymphoma,)

Statistical computation was conducted using PAWS statistics 18 (SPSS Inc., Chicago, IL). All statistical analyses were two-tailed and P value\0.05 was considered statistically significant.

Table 4: anatomical distribution of meningioma

meningioma	**Total: 240**
1-Basal	199
Sphenoid wing	90
petroclival	12
Cpa clinicp	56
Cavernous clinoid	26
Olfactory groove	7
Foramen magnum	2
2-calvarial	41
convexity	10
Falx cerebri/ cerebelli	28
parasagittal	3

Table 5: distribution of neurofibroma

neurofibromas	149(total number)
1- site	
insitu	89
Touching brain stem	43
Displacing brain stem	17
2-size	
Less than 40mm (max.diameter)	99
More than 40 mm(max. diameter)	50

Table 6 :gliomas distribution

Gliomas	148
Site	
Brain Stem	22
Thalamic	20
Cereberal	76
Cerebellum	30

Table 7: pituitary adenoma

Pituitary adenoma (121)	
1-site	
intrasellar	97
Suprasellar + parasellar	24
Treatment mode	
1st look	97
Post op.(cranial & or nasal)	14
Post gamma	10
2- Activity	
Non functioning	73
functioning	48
prolactin	41
acromegaly	10

Table 8: brain secondaries

Brain secondaries (65)		
Single lesion (48)	Two lesions (11)	More than two (6)
Female (30)	Male (35)	
Breast (21)	Bronchogenic (30)	
Gyn (5)	Colonic (3)	
Thyroid (4)	Prostate (2)	

Table 9: post GK session improvement in brain secondaries

Post GK session improvement	
3-6 months follow up	30%
6-9 months	45%
9-12 months	50 %

Table 10: treatment mode of pinealomas

Pinealomas (15)		
Treatment mode		
Postoperative (1)	First look (14)	
Size		
Less than 20 mm max diam.	20-30 mm max. diam.	More than 30 mm max. diam.
9	4	2

Table 11:craniopharyngiomas(composition & treatment mode)

Craniopharyngiomas (14)	
Compositions	
Solid (4)	Solid & cystic (mixed) (10)
Treatment mode	
First look (1)	Postoperative (13)

Table 12: other rare tumors

Others (21)				
Glomus juglare	Chordoma	chondromas	nasopharyngeal	total
4	5	4	8	21

Table 13: arteriovenous malformations distribution

Site						
Brain stem	thalamic	paramidline	sylvian	basal	interhemispheric	subcortical
11	19	40	13	7	3	9

Table14: treatment mode & % of improvement in avm

Treatment mode			total
One session(less than 30mm in max. diam		90	102
Multisessions (more than 30 mm in max. diam.)		12	
Improvement			
3-6 months post gamma knife	6-9 months post gamma knife	9-12 months post gamma knife	
25%	50%	65%	

Table15: distribution & treatment mode of trigeminal neuralgia

Trigeminal neuralgia (178)			
Right		Left	
140		38	
Anatomical distribution			
V2 V3	V2	V3	V1 V2
117	29	30	2
TREATMENT MODE			
FIRST LOOK	Post previous gamma session	Post local injection	Post microvascular decompression
125	27	20	6
Improvement			
First look	Post previous gamma	Post local injection	Post microvascular decompression
88 (70%)	12 (44%)	10 (50%)	2 (33%)

Table16: mesial temporal sclerosis distribution

Mesial temporal sclerosis (6)	
Unilateral (5)	Bilateral (1)

DISCUSSION:

Gamma knife radiosurgery is indicated for treatment of a wide range of brain tumors and other intracranial lesions.

In our study, the median age is 33 y ranging from 4-78 y, & male : female equal to 1.3:1,&this distribution according to the presenting pathology as in other studies [18,19]

In our study , brain tumors are the most common cases treated by gamma knife and the meningioma at the top of the list, the least is nasopharyngeal carcinoma

Regarding non-tumor brain lesions, in our study, AVM that treated by GK constitute about 10% from total cases , trigeminal neuralgia 18% from total cases, and only 0.06% for treatment of epilepsy caused by mesial temporal sclerosis.

In our study 240 cases of meningioma treated by GK , distributed as 199 basal type ,sphenoid wing at the top with 90 cases & foramen magnum the least with 2 cases.

The calvarial type about 41 cases ,the convexity at the top with 10 cases & parasagittal the least with 3 cases. Also, in other studies ,the basal type constitute the most common that treated by GK radiosurgery & mostly the cavernous type, and this due to difficulties in removing these tumors totally or the patients are not candidate for open surgical resection.[20,21]

The second most common tumor in our study was neurofibroma in cerebellopontine angle region. In most cases the tumor touching the brain stem with a less extent displacing the brain stem.

Regarding the tumor size, most of the cases measured less than 40mm in diameter with a less extent more than 40 mm in diameter. As in other studies, the CPA constituted the most presenting site involving the vestibular nerve & attaching or displacing the brain stem according to size .[22]

Cases of glial tumors that were treated GK constituted the 3rd most common type. Regarding the site ,the cerebral in the top followed by cerebellar , the least is thalamic, brain stem glioma either diffuse or focal. 37% are first look ,33% with previous surgical intervention & 30% with previous surgery & radiotherapy. Also in other studies where GK considered as an adjuvant or alternative treatment option for glioma especially in recurrent & critical location of tumor [23,24] , also the distribution according to the site reflect the possibilities and difficulties of surgical resection.

Regarding pituitary adenoma in our study the most involving cases are first looking non-functioning adenoma with intrasellar extension ,while the suprsellar involvement of functioning adenoma treated previously either by open cranial or trans sphenoidal surgery or previous GK. Radiosurgery session. As in other studies, nonfunctional adenoma constitute the most presenting type of adenoma [25,26]. In other studies, Gk radiosurgery considered as adjuvant or alternative primary treatment especially in acromegaly and non functioning adenoma particularly when there is pressure effect[27] .

In brain secondaries ,single lesion constitutes the most brain lesions while 2 or more are less. breast & bronchogenic ca. causing the most brain secondaries in female & male respectively. Other studies shows the same results[21, 28] .

In pineal body tumor,15 patients treated by GK , only 1 had previous surgery ,while the others primarily treated by radiosurgery.as in others that all cases primarily treated by GK, with good response [29] .

Fourteen cases of craniopharyngioma treated by GK . only 1 after first look & the other 13 had previous surgical interventions, as in other studies where GK treatment followed surgical intervention. [30]

In this study ,102 cases of arteriovenous malformations treated by GK- radiosurgery, distributed mostly in paramidline, thalamic, Sylvian &brainstem respectively with a lesser extent to other sites .about 88% (90 patients)with less than 30mm in diameter & treated with one session , and about 12% (12 cases) need more than one session with a size more than 30 mm in diameter. The rate of clinical improvement with a lesser extent radiological , increasing from 25%, 50% , 65% after (3-6),(6-9) & (9-12) months post GK sessions respectively .

Regarding trigeminal neuralgia , in our study we treat 178 cases , most of them (125) was 1st look, & the remaining cases had history of previous GK sessions, previous local injections or history of previous microvascular decompression . the most anatomical distribution is right side with V2 V3 & the least is V1 V2.

Regarding the outcome ,was seen more with 1st look cases (70%) & the least with post microvascular decompression (33%) ,which is nearly equal to other studies with initial success rate between 77% -57% depending either first look or previously treated by microvascular decompression which is superior than GK radiosurgery if the surgery is possible & indicated with presence of attached vessel [31,32]

In mesial temporal sclerosis that is causing epilepsy we treat 6 patients ,5 of them unilateral & 1 bilateral ,and this non invasive treatment with GK radiosurgery is comparable to surgical resection with lesser morbidity [33]

CONCLUSION:

Gamma knife radiosurgery is one of the new, non- invasive procedures That proved to be an effective maneuver in the treatment of brain lesions and other functional disorders with fewer side effect.

RECOMMENDATION:

Adoption of this study as a cornerstone to other Iraqi studies to publish Iraqi Guidelines in Gamma knife Radiosurgery.

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