RESEARCH ARTICLE
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Efficacy and Evaluation Dose Distribution For Acoustic Neuroma Tumor By Using The Gamma Knife Radiosurgery

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ABSTRACT

Background: Misdiagnosis of acoustic neuromas in clinical practice is common, and they share similarities with other brain tumors in terms of imaging symptoms and area of incidence. The most recent iteration of the gamma knife technique known as “lightning” was utilized in this investigation with the purpose of analyzing the plans of vestibular schwannomas by the most recent formula for assessing the tumor.

Purpose: evaluation indices include selectivity, Gradient Index (GI), and Paddick Conformity Index (PCI).

Methods: A cross-sectional study. Evaluation dose was determined for every desired TV volume of the sixty patients who had Stereotactic Radiosurgery (SRS) performed on them in order to treat vestibular schwannoma, Calculating this parameter required developing a theoretical concept for operational sphericity, which was done and following are some of the measurements that are used in the analysis of the values that were found: Coverage (C), Selectivity (S), Gradient Index (GI), Paddick Conformity Index (CI Paddick), and Dosage Distribution (IV/TV).

Results: The patients included in this study, the patients’ average age was 44.54 ± 11.93 years ranging from (20-75) years and the prevalence of females in this study is 35 (70%) more than the males 15 (30 %). The prescribed dose for vestibular schwannoma patients was 12 Gy. The mean target volume is 5.367 ± 0.058 cm3, ranging from (0.079-26.497) cm3.

Conclusion: This study shows that divided the tumor into spheres, the first sphere delineates the regular part of the tumor, and the second sphere is delineated irregular cancer components, Since the plan of reference is a spherical target, the degree of sphericity is an excellent parameter to use when evaluating the dose dissemination of a strategy for the treatment of vestibular schwannoma. and utilizing a Leksell Gamma Knife® Icon (LGKI). According to the findings of this study, dividing the tumor into two halves provides valuable information regarding the distribution of the dose both within and outside the target volume.

Keywords: Stereotactic radiosurgery, Acoustic neuromas, Gradient index, Selectivity, Coverage.

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INTRODUCTION

Gamma Knife Radiosurgery (also known as GKRS) is a treatment that has been thoroughly researched and is proven to be both safe and effective[1]. Modality for patients who have been carefully selected, but despite its high overall efficacy, it carries some risks, including facial nerve paresis, hearing loss, and the progression or recurrence of the tumor[2,3].

In the treatment of vestibular schwannoma, radiosurgery is frequently utilized[4]. The radiosurgery treatment is a non-invasive treatment that provides the tumor with high-dose radiation while reducing the damage to the adjacent, healthy brain tissue[5]. Beams of high-energy X-rays or gamma rays are used to deliver the radiation to the tumor. The goal of the radio surgical treatment for acoustic neuroma is to permanently stop the tumor from growing[6].

In our study the spheroid system was applied to the tumor, in order to better understand the sphericity (φ) concept was applied to the split target volume.

A measure of how closely an irregular Volume's (V) form resembles that of a sphere was given the definition of sphericity[7].

It is possible to compare the Target Volumes (TV) of the various shapes to that of a sphere. Volume, surface area, and the proportions between the orthogonal axes are all taken into consideration. In its theoretical formulation, operational sphericity. Using quality indicators that have already been defined, physicians and physicists evaluate the plans for radio surgical therapy with gamma knife equipment. This review is done by the medical professionals, and these measurements, which include Coverage (C), Selectivity (S), Gradient Index (GI), and Conformance Index (CI) (CI paddick). They are derived using dosage ranges that take into account the volume of the isodose prescribed, the target's volume, the amount of the isodose that is equivalent to fifty percent of the recommended isodose and the point where these volumes overlap[8].

This study's objective was to look into the worldwide dose distribution by making use of the ratio (IV/TV) in the context of radiosurgery planning while also taking into account alternative isodose volumes of varying sizes besides the prescribed isodose. The low doses as well as the dose gradient inside the target volume are also things that this test is supposed to measure. It was attempted to find a correlation between the goal volume and the degree of sphericity of existing indicators. This is significant because utilizing this analysis, we will be able to investigate whether or not it is possible to enhance the evaluation of the plans by making use of the sphericity degree. Consequently, in order to construct this study using the dose distribution that was acquired for the purpose of designing a two-sphere arrangement with a comparable volume; it will be consulted for planning purposes[9].

MATERIALS & METHODS

For six months, a cross-sectional study was conducted. .Choosing sixty patients who had been diagnosed with vestibular schwannoma by an oncologist or a neurosurgeon and then having them undergo gamma knife treatment. After patients were diagnosed and referred to the gamma knife treatment, three-dimensional detailed anatomical images of the vestibular schwannomas tumor were acquired using a Magnetic Resonance Imaging (MRI) prototype manufactured by Philips called the Achieva 3 Tesla or 1.5 Tesla. These models were used to acquire the images. The bone and other solid structures of the head are then acquired with the help of Cone Beam Computed Tomography (CBCT), which is mounted on the device known as the gamma knife.in general the MRI using in gamma knife called MRI gamma knife protocol.

Inclusion Criteria:

1. Patients with vestibular schwannomas tumor and underwent a surgery.

2. Patients who refuse removed the vestibular schwannomas surgically.

3. Patients who did not have benefit with linear accelerator.

Exclusion Criteria: All patients with other tumor such as meningioma, Arteriovenous Malformation (AVM), neuroma, acoustic neuroma, and pituitary tumors in gamma knife radiosurgery.

Statistical analyses: The statistical tool known as Statistical Packages for Social Sciences, version 25 (SPSS-25), was used to analyze the data.

DISCUSSION

The mean age of the patients 44.54 ± 11.93 years with range (20-80) years. Gender composition of the patients was 15 (30%) Male and 35 (70%) Female. The female in this study shows more prevalence than male patients. In this study, one tumor was taken vestibular schwannoma only. The prescribed dose for vestibular schwannoma patients was 12 Gy. Which the neurologist chooses depending on the tumor volume, location, and histopathology. The vestibular schwannoma tumor is irregular in shape(10), for this reason can divided The tumor into spheres; the first sphere delineates the regular part of the tumor, and the second sphere is delineated irregular cancer components .The irregular sphere less than regular sphere in size that difference in size give rise to increase the Mean Dose (Gy), Minimum Dose (Gy), Maximum Dose (Gy), and Integral Dose (mJ) for the regular sphere at value according to the readings taken in the table (3.2)chapter three at same the table shown in the results the regular and irregular spheres for vestibular schwannoma dose parameters Significant in Maximum (Gy) and Integral Dose (mJ) when using p–value ≤ 0.05 level **(Table 1)**.

Sphericity Degree (φ) and evaluation parameters, regression curve was used to estimate the correlation

Table 1. Regular and irregular spheres for vestibular schwannoma dose parameters.

Parameters	Regular Sphere	Irregular Sphere	p-value
Mean (Gy)	23.26 ± 4.94	21.53 ± 6.01	0.1108
Minimum (Gy)	10.18 ± 1.64	8.95 ± 1.61	0.0881
Maximum (Gy)	34.47 ± 4.21	32.85 ± 5.24	0.007*
Integral dose (mJ)	73.66 ± 6.16	25.51 ± 2.68	< 0.00001

* Significant Difference at p–value ≤ 0.05 level.

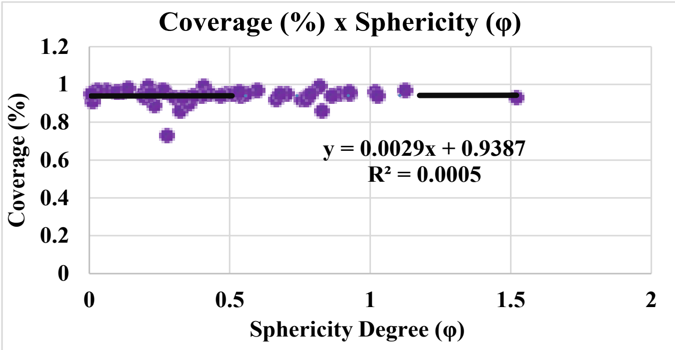

Figure 1: Correlation between the sphericity degree and coverage.

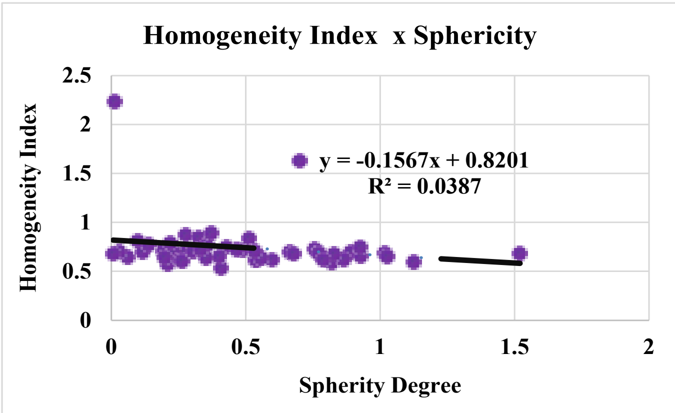

Figure 2: Correlation between the sphericity degree and homogeneity index.

between the overall sphericity degree and, most important the evaluation parameters such as coverage, selectivity, Homogeneity Index (HI), selectivity, Gradient Index (GI), and shot density. The results show that there is a direct correlation between coverage and sphericity degree, selectivity, and gradient index. While an inverse correlation appeared between the sphericity degree, homogeneity index, and shot density.

Coverage (C): A trend line was established in the results **(Figure 1)** by applying a straight line adjustment to the obtained data. When the sphericity number rises, it indicates that the Coverage value will also rise.

Homogeneity Index: (Figure 2) to create a trend line in the results, a straight line was used to alter the collected data. The correlation between them was (r =0.0387), which shows that the homogeneity value decreases as the sphericity value grows.

CONCLUSION

The findings of this investigation were presented in, and they offer data that can be used to describe how the dose distribution (IV / TV) behaves in relation to the target volume's degree of sphericity. The newly proposed study of dose distribution that makes use of the sphericity degree is simplest to explain and simplest to compute. Because of this study, a more comprehensive assessment of the dose gradients surrounding the TV and the dose distribution inside and outside the target volume can be performed, resulting in a bigger amount of information a variety of different isodose lines. The sphericity degree is a useful tool when making an objective comparison between two or more treatment plans and determining whether or not it is possible to improve the plan taking low-dose spreading into consideration. As vestibular schwannomas tumors grow larger, they become more spherical, which leads to improved plan quality.

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