Hearing outcome following γ-Knife treatment of vestibular schwannomas. A series of 33 cases

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Abstract

Due to the progress in neuro-imaging vestibular schwannomas (benign tumors rooting from Scwann cells of vestibular nerve) witness an increase in incidence in the last decade. Despite the advances in operating techniques and intraoperative technologies used surgery still presents a rate of morbidity and mortality. Gamma-knife became a therapeutic alternative for selected cases of vestibular schwannomas. However, the results of gamma-knife radiosurgery showed an influence on the audiograms of the patientstreated with this technique. The goal of our study is to assess the measure in which gamma-knife treatment influences the neuro-otologic behavior of these tumors. We study a series of the 33 consecutive cases which completed a 24 months follow-up after gamma-knife treatment. We use a neuroimagistic and neuro-otologic protocol aproved by our institution.

24 patients didn't show a deterioration of the audiogram. Among these 11 report an unmodified hearing function, while 11 describe an improvement in hearing (we excluded the cases with complete hearing loss.

We manage to show that strictly following the patient selection criteria for gamma-knife treatment, radiosurgery is a safe treatment option for the patients with small to medium-sized vestibular scwannomas.

Keywords: audiogram, gamma-knife, radiosurgery, vestibular schwannoma

Introduction

Analyzing the results of Gamma-knife treatment on patients with vestibular schwannomas (within a 4 years monitoring period) we observed certain changes in audiograms. The goal of the present study is to have a measure of photonic radiation treatment effect on the neuro-otologic behavior of these benign tumors.

Histologically, vestibular schwannomas are benign tumors that grow from the Schwann cells of the 8th cranian nerve. Due to improved neuroimaging the incidence of vestibular schwannomas within the general population increased. However, despite the advances in introperatory techniques, surgery still carries a risk for morbidity and mortality. Depending on tumors characteristics vestibular schwannomas can be treated by different methods, other than neurosurgery. Radiosurgery is one of these non-invasive techniques that can be used to treat vestibular schwannomas. It uses gamma radiation (photons) and is known as "Gamma-knife" or "γ-Knife".

Materials and Method

We study a series of the 33 consecutive cases which completed a 24 months follow-up (at 6, 12, and 24 month) after gamma-knife treatment. We use a neuroimagistic and neuro-otologic protocol aproved by our institution.

We used a Leskell 201 with 611C source (photonic unit) in the treatment procedure.

The patients included in the study presented bilateral vestibular schwannomas with partial or total hearing loss.

Inclusion criteria were as follows:

- Increase in overall dimansions of small to medium-sized tumors in patients older than 65 years of age
- Increase in overall dimensions folowing partial surgical removal, independent of patient age
- Poor general status
- Patient's decision to undergo Gamma-knife treatment following a in-depth discusion with his doctor.

Results

For all the patients in the follow-up we looked exclusively at the neuro-otologic results, regardlessof age, sex, or tumor size before and after γ-Knife.

Clinical evaluation of the patients outcome at each monitoring session the usual questions asked were: "How do you feel after the treatment?" and "How is your hearing?". Considering the possibility of answer subjectivity we decided for this study to use audiogram as a objective measure of radiation effect on neuro-otologic function.

From the total number of patients, 4 (10.6%) declaired hearing deterioration, 21 (55.2%) indicated no change in hearing function, while 13 (34.2%) indicated an improvement in hearing.

Subjective perception aside we focus on the quantitative differences in audiograms from the time of the treatment up to two years follow-up.

We notice that out of a total of 33 patients modified audiogram was obtained in 24 cases. In 15 cases the audiometric curve was shifted towards high frequences, while in 9 cases the cruve shifted towards lower frequencies. At a normal audiogram recording (10dB) we measure the curve shift ith a 5dB treshold.

TABLE 1

Number of patients with changes on the audiogram

Modified audiogram	Unchanged audiogram
24	9

TABLE 2

Details for the patients that didn't show a significant shift in audiogram

Patient	T = 0 (2 KHz)	T = 24 m (2 KHz)	T = 0 (4 KHz)	T = 24 m (4 KHz)	Change in hearing
A	52	61	66	58	Improvement
B	36	34	20	19	No change
C	50	48	60	61	No change
D	100	100	100	100	Total loss
E	50	48	60	61	Improvement
F	61	58	63	60	No change
G	39	39	28	26	Improvement
H	52	50	59	55	No change
I	92	90	88	83	Total loss

TABLE 3

Details for patients with improvements in audiogram

Patient	T = 0 (2 KHz)	T = 24 m (2 KHz)	T = 0 (4 KHz)	T = 24 m (4 KHz)	Change in hearing
A	91	77	100	78	No change
B	72	50	60	48	No change
C	52	10	50	42	Improvement
D	44	20	40	20	Improvement
E	72	66	55	58	Improvement
F	81	68	92	76	No change
G	60	41	60	57	Improvement
H	42	16	46	38	Improvement
I	48	28	41	27	Improvement
J	82	74	59	49	Improvement
K	71	64	73	64	No change
L	41	30	48	41	Improvement
M	83	50	69	60	Improvement
N	44	36	42	32	No change
O	78	63	50	52	No change

TABLE 4

Patients with audiogram deterioration

Patient	T = 0 (2 KHz)	T = 24 m (2 KHz)	T = 0 (4 KHz)	T = 24 m (4 KHz)	Change in hearing
A	64	77	58	78	No change
B	54	63	65	74	No change
C	41	60	60	70	Deterioration
D	66	75	53	70	Deterioration
E	52	58	50	62	No change
F	53	61	60	73	Deterioration
G	66	71	58	66	No change
H	63	72	60	68	No change
I	50	63	48	61	Deterioration

Discussion

As described by our results only 9 out of 33 patients that underwent Gamma-knife treatment showed changes in audiograms. Furthermore, asked how is their perceived hearing function after the treatment, 5 patients responded that it wasn't affected by the radiation therapy (patients with complete hearing loss prior to the treatment aside).

From the 9 patients that didn't manifest a significant change in their audiogram during the 24 months following gamma-knfe treatment, acustic acuity remained unchanged in 4 cases (compared to the pre-treatment acuity), while 3 of them showed an improvement in hearing.

Finally, from the 15 patients that showed a significant improvement their audio-metric diagram ($\Delta dB > 5$, with an interval from 6 dB to 42 dB at 2 KHz, and from -3 dB to 22 dB at 4 kHz, respectivelly), 7 of them reported an improvement in hearing while for the other 8 there was no change in hearing.

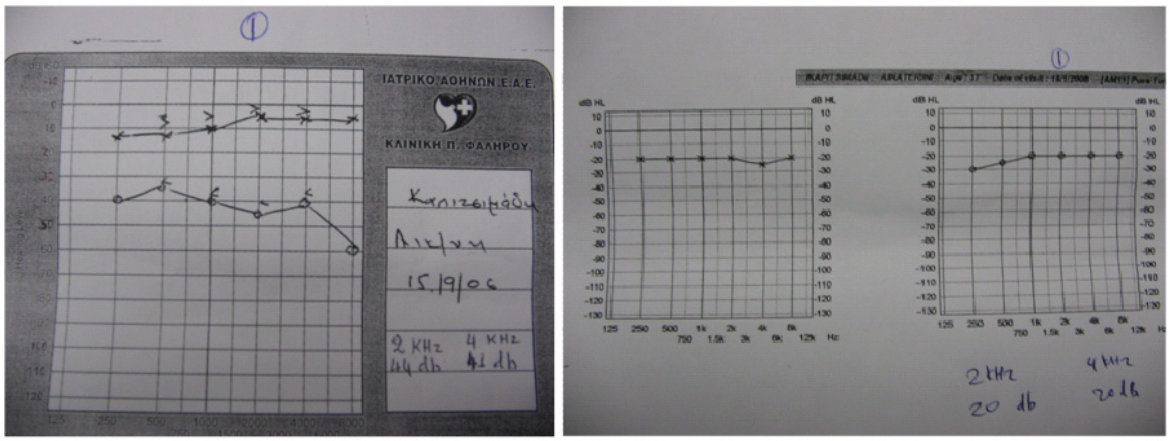

Figure 1 Patient K.A. Left: Audiogram in 2006 (34 yrs.) proir to γ-Knife, 44 dB at 2 kHz, 41 dB at 4 kHz. Right: Audiogram in 2008 (36 yrs) at two years after the treatment, 20 dB at 2 kHz, 20 dB at 4 kHz

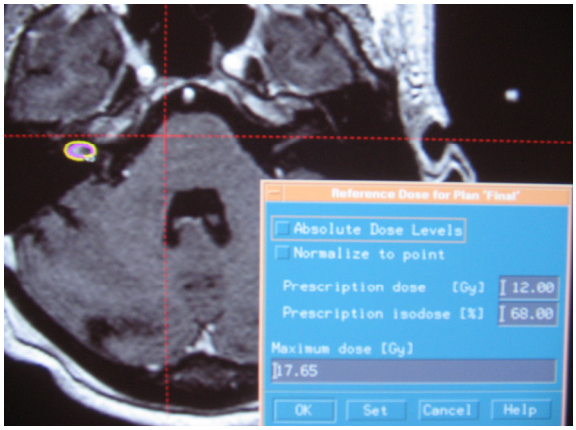

Figure 2 Reference dose for the final therapeutic plan (12 Gy = 68 %, Vol= 34,7 mm^2)

Conclusions

From a total of 24 patients that dind't show a significant change in audiograms, 11 of them report no modifications in hearing, while 11 describe an improvement in hearing (we disregard the cases with complete hearing loss). While these data do not show unequivocally that a change in audiogram („quantitative gain") is equivalent to a perceived improvement in hearing („qualitative gain") it shows however that complying to strict criteria of patient selection for gamma-knife therapy makes this therapy a safe one for treating small to medium sized vestibular schwannomas. This therapy insures the preservation of the existing auditory acuity and even a significant improvement in a number of cases.

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