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Patient perception of disability following acoustic (vestibular) schwannoma removal via gamma knife and microsurgical techniques

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PATIENT PERCEPTION OF DISABILITY FOLLOWING ACOUSTIC (VESTIBULAR) SCHWANNOMA REMOVAL VIA GAMMA KNIFE AND MICROSURGICAL TECHNIQUES

by

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Abstract: This study evaluates patient's short and long-term balance function after microsurgical tumor removal and gamma knife radiosurgery using an unvalidated qualitative questionnaire and the Dizziness Handicap Inventory.

INTRODUCTION

Vestibular schwannomas (sometimes referred to as acoustic neuromas) are tumors that arise from the intracranial Schwann cells of cranial nerve VIII. These benign tumors represent approximately 10% of all the primary brain tumors (Weber et al, 2003). The yearly incidence is 1 per 100,000 (Kaylie & McMenomey, 2005). They are generally slow growing tumors. Nonetheless, vestibular schwannoma growth tends to result in the compression of surrounding neurovascular structures. Patient symptoms may include hearing loss, tinnitus, dizziness/balance issues, facial nerve paralysis and trigeminal nerve disorders.

Tumors are classified as Grade 1, Grade 2, Grade 3, Grade 4, or Grade 5 based on size:

Grade 1) small tumors measuring 1-10 mm

Grade 2) medium tumors measuring 11-20 mm

Grade 3) moderately-large tumors measuring 21-30 mm

Grade 4) large tumors measuring 31-40 mm

Grade 5) giant tumors those measuring more than 40 mm (Kanzaki et al., 2003).

Advances in modern imaging techniques have allowed for the detection of exceedingly smaller tumors (as small as 2 mm). Tumors this small may have gone undiagnosed in past decades (Swan, 2000). This early identification of tumors provides physicians three different treatment options: watchful waiting, microsurgery and gamma knife radiosurgery.

The first option (watchful waiting) is most often utilized for smaller tumors or patients who have been deemed poor surgical candidates (Kaylie & McMenomey, 2005). Elderly patients with deficient general health are an example of a poor surgical candidate. Conversely, choosing the watchful waiting option for a patient who is a surgical candidate can lead to a future poor surgical candidate (an older patient with a larger, more difficult to remove tumor) (Sandooram et al., 2003). This makes watchful waiting a potentially hazardous option. Due to this, microsurgery and gamma knife radiosurgery are chosen for most patients (Kaylie & McMenomey, 2005).

The second option is microsurgery. The purpose of microsurgery is complete removal of the tumor. Surgical resection of a vestibular schwannoma was first performed in 1894 by Sir Charles Ballance. In Ballance's time, morbidity and mortality rates were exceptionally high. Advancements in surgical procedure include the adaptation of the surgical microscope by William House in the early 1960's (House, 1977) and the development of improved surgical approaches. At present, there are three surgical approaches that are most widely used:

1) The enlarged translabyrinthine approach (ETLA), which allows the total removal of the majority of the tumors independent of their size, with partial or no cerebellar retraction.
2) The retrosigmoid approach (RSA), a routine operation in the field of neurosurgery for the removal for the removal of various sized acoustic neuromas. Both the translabyrinthine and retrosigmoid approaches are frequently used in cases where tumors have a significant posterior fossa cisternal component (Kim et al., 2004).
3) The enlarged middle fossa approach (EMFA), performed for the removal of intracranial tumor and/or with a maximal extrameatal extension of 0.5 cm (Sanna et al., 2004). This approach is predominantly used for intracranial tumors with minimal extension beyond the porus acusticus (Kim et al., 2004).

Whereas morbidity (i.e. dizziness, hearing loss, and facial nerve paralysis) is still a concern when performing microsurgery, mortality rates have significantly been reduced (House & Shelton, 1992). The morbidity rate (i.e. dizziness, hearing loss, and facial nerve paralysis) varies based on the surgical approach. However, for the purpose of this study microsurgery will be assessed as one group.

The third treatment option is gamma knife radiosurgery. Stereotactic radiation was pioneered by Swedish neurosurgeon Dr. Lars Leksell in the 1950's (Suh et al., 2004). Gamma knife radiosurgery was not used to treat vestibular schwannomas until 1969 (Sanna et al., 2004). Gamma knife radiosurgery is currently performed in a single session. This technique entails collimated beams of radiation from a cobalt 60 source which target a defined intracranial location. The goal of this treatment option is to induce avascular necrosis and collagen deposition, making the tumor unable to grow (Kaylie & McMenomey, 2005).

Research has been performed trying to determine which therapy option has the best outcome for patients. There are a multitude of ways to assess each treatment modality. These past studies have been quality of life studies, symptom specific studies, and comparative studies. However, balance outcome has been relatively poorly studied in comparison to hearing and facial nerve function studies.

LITERATURE REVIEW

Quality of Life Studies

Studies on vestibular schwannoma treatment outcome have often relied on quality of life tools such as the Glasgow Benefit Inventory (GBI) (Robinson et al., 1996) and the Short Form-36 (SF36) (Ware and Sherbourne, 1992). Both of these tools are somewhat general, featuring questions such as “Do you feel better of worse about yourself?” or may have general questions like “Are there more or fewer people who really care about you?”

The GBI was developed especially for patients who have had otorhinolaryngological interventions (Robinson et al., 1996). The GBI is a validated questionnaire and allows for comparisons to be made between interventions. Because of this, the questions on the GBI were generated to measure a general perception of wellbeing rather than a particular symptom.

The SF36 is an outcome measure developed to be used as a tool to assess the health status after medical and surgical treatments (da Cruz et al., 2000). SF36 was validated by administering the questionnaire on both healthy people and those who have undergone medical or surgical treatment in order to confirm that there is a divergence in scores. The disadvantage of using this test is that it is a universal questionnaire for any medical or surgical treatment and that it is not symptom specific.

A study conducted by da Cruz et al. (2000) used the SF36 to evaluate treatment outcomes after vestibular schwannoma surgery. This study assessed 72 patients who had undergone vestibular schwannoma excision 18 or greater months prior to the time of the investigation. The results of the study were that patients who have surgical removal of vestibular schwannomas have a reduced quality of life compared to matched peers in the general population. However, this study did not focus on specific patient reported morbidities nor did the investigators compare microsurgical with either of the other treatment options.

Another study performed by Nikolopoulos et al. (1998) used a questionnaire based on the GBI to evaluate quality of life after acoustic neuroma (vestibular schwannoma) surgery. They looked at 53 patients one to three years post-treatment. The researchers in this study concluded that there is a possibility of a patient’s quality of life being negatively affected by having vestibular schwannoma surgery regardless of tumor size and therefore patients should be thoroughly informed about the consequences of the operation. The focuses of this study were issues such as financial status and occupation rather than specific surgical morbidities (i.e. hearing loss or vestibular dysfunction).

One study that examined the post-treatment results of patients who had microsurgical vestibular schwannoma removal using a general QOL questionnaire as well as a disease specific questionnaire was performed by Irving et al. (1995). Researchers used both a general questionnaire called the European Organization for Research into the Treatment of Cancer (EORTC) core and a vestibular schwannoma disease specific module. The EORTC assesses quality of life and physical condition using a 7-point scale ranging from very poor to excellent (Smith et al., 1999). The added disease specific module included questions related to the function of cranial nerves V, VII, and VIII. The 227 patients who took part in the survey had a significant difference in subjective functional outcome between those whose tumors were less than 1.5 cm in maximum diameter and those whose tumors were greater than 1.5 cm in maximum diameter. Patients who had smaller (less that 1.5 cm) tumors had a significantly better outcome. However, there was not a significant difference between those with tumors 1.5 to 2.5 cm and those with tumors larger than 2.5 cm. The Irving et al. (1995) study did not reveal any subjective functional differences on the basis of the age of the patient. These authors found that the patients' overall quality of life following vestibular schwannoma excision was excellent. The distribution of patients who had a poor functional outcome was equal across the tumor size range. This study did give more detailed insight to patients and physicians as to what the surgical outcome may be for patients. However, this study did not access the outcome of either of the alternative treatment options.

These studies provided general information for an intervention not based on specific morbidities of patients. However, a more focused evaluation of treatment outcomes would most times be preferable. For vestibular schwannomas, these treatment outcomes involve hearing, tinnitus, facial nerve function, as well as balance function.

Symptom Specific Studies

Wiegand and Fickel (1989) completed a large symptom specific postal questionnaire on 541 members of the American Neuroma Association who underwent surgical tumor removal. This retrospective study looked at the above listed subjective treatment outcomes (hearing loss, tinnitus, facial nerve function, and balance function) and other nonotologic issues: eye-related issues, depression, anxiety, headache, sleep disturbance, patient independence, self-image, fatigue, dental problems, speech or swallowing difficulty, and sexual dysfunction. The results of the balance section of the questionnaire revealed that 90% of these patients reported disequilibrium. Nevertheless, only 8% of patient responded that they felt severely handicapped by the disequilibrium. 30% of respondents with dizziness indicated that dizziness was improved or cured by surgery. 1% of patients believed their dizziness worsened after surgery. The patients also listed conditions which seemed to make dizziness worsen including fatigue, darkened surroundings, and change in position. This study did not include any gamma knife patients.

Another study that focused on specific post-treatment symptoms was done by Ryzenman et al. (2004). This was a postal questionnaire of 1940 members of the Acoustic Neuroma Association. This questionnaire asked patients to list the "most difficult aspect of the AN (acoustic neuroma) experience." The researchers analyzed the responses by considering the patient's tumor size, surgical approach, age, and sex. Men reported hearing loss, balance problems, perioperative surgical experience, and eye and facial weakness (in that order) as being most problematic. Women had the most trouble with hearing loss, facial weakness, eye problems, and headaches respectively. Patients (both men and women) who had large tumors, were younger in age, and who underwent the retrosigmoid approach reported facial weakness more frequently. Patients over the age of 75 years tended to report more balance dysfunction. Patients who had small tumors frequently reported headaches and balance problems. This study provided important information regarding surgical treatment outcome.

Darrouzet et al. (2004) researched the short and intermediate postoperative complications that patient experience following vestibular schwannoma surgery. The authors did a chart review of 400 patients. The vestibular results section of the study revealed that acute vertigo was a common complaint (45.5% of patients) during the period immediately following surgery. 78.2% of patients revealed that unsteadiness was "troublesome." 30% of patients were still experiencing vestibular disturbances one year post-treatment. The researchers involved in the study did not review the charts of gamma knife or watchful waiting patients.

Gjurić et al. (2001) performed a retrospective case review of 735 patients who had surgical removal of vestibular schwannomas. Researchers analyzed facial nerve function, hearing preservation, and the percentage of the tumor able to be removed for each patient. This large study provided valuable information regarding surgical outcome. This study, as well as past studies, omitted vestibular status as part of vestibular schwannoma treatment outcome reporting.

Several studies have also used validated questionnaires as a way to analyze specific effects of vestibular schwannoma treatment on patients. Humphriss et al. (2003) used the

Dizziness Handicap Inventory to assess the change in vestibular function of 100 consecutive patients undergoing tumor excision. The authors found that for the majority of patients there were no change in DHI scores after excision. In those patients whose scores did worsen, there were significant drops between the preoperative time and the three month postoperative time period and then scores did not continue to decline after three months. Researchers have also studied the Tinnitus Handicap Inventory (Baguley et at., 2005) and Hearing Handicap Inventory (Humphriss et al., 2004) scores of patients who have undergone surgical removal of vestibular schwannomas. The foregoing studies did not administer these questionnaires to gamma knife patients.

Looking at past studies it can be noted that previous research focuses primarily on microsurgical treatment of vestibular schwannomas. One study done by Wackym et al. (2004) did examine the outcome of gamma knife radiosurgery when treating acoustic neuromas (vestibular schwannomas). The study was a prospective assessment of 33 patients. Researchers looked at tumor control, changes auditory threshold and speech discrimination, tinnitus, facial nerve function, trigeminal nerve function and balance function. Vestibular function was assessed using bithermal caloric testing. After gamma knife radiosurgery 17 (71%) of the 24 patients tested experienced some disequilibrium. New onset dizziness was seen in eight patients. One patient had dizziness prior to treatment which resolved by the 12 month follow-up visit. This study did not administer any subjective patient questionnaires.

Comparative Studies

Seldom have researchers compared the outcomes of the methods of treatment (Nikolopoulos & O'Donoghue, 2002). One without consideration of balance was the one done by Shirato et al. (1999). The two treatment options compared were gamma knife radiosurgery and watchful waiting. The study group consisted of 27 patients. The researcher involved in this study examined tumor growth rate and hearing levels. The results of the study revealed the tumor control rate was better for the gamma knife study group compared to the watchful waiting group. The two groups had similar hearing deterioration rates. There was no consideration of balance.

A study done by Myrseth et al. (2005) evaluated treatment outcome in terms of facial nerve function (House-Brackman Grade 1-2), hearing, complication rates and general quality of life. The researchers in this study used both the SF36 and the GBI to assess the quality of life for both microsurgical and gamma knife patients. The results of this retrospective study showed that patients are somewhat happier with gamma knife than with microsurgery. Nonetheless, these authors did not include specific questions regarding vestibular function in their assessment.

With the wealth of research on the subject of vestibular schwannoma outcome, physicians can better counsel and recommend appropriate management strategies. However, research has shown that even when patients are "educated" about all three vestibular schwannoma treatment options, physicians can be biased and will convey this bias to patients (Pogodzinski et al., 2004). Therefore, it is crucial that physicians have research data to reference when discussing patient options. Imbalance associated with each option has not been extensively studied. Thus physicians and patients are unable to include the level of imbalance post-treatment into their decision making process.

The aim of this study was to evaluate short- and long-term balance function after microsurgical tumor removal and gamma knife radiosurgery.

METHODS

This study was approved by the Human Studies Committee of Washington University School of Medicine.

PARTICIPANTS

The study was an analysis of a retrospective postal questionnaire. This study was performed on a group of patients who had been treated at Washington University School of Medicine for vestibular schwannomas. The study group was collected from a database of consecutive series of 60 patients whose complete medical record was available at Washington University School of Medicine. The patients had undergone either microsurgical tumor removal (n = 29) or gamma knife radiosurgery (n = 31). Patients were mailed the questionnaires and asked to return them in a prepaid envelope. Of the mailed questionnaires, 34 were returned. Three patients who returned questionnaires were excluded because they underwent both microsurgical tumor excision and gamma knife radiosurgery. The remaining 31 patients are the subject of this report.

MATERIALS

Each questionnaire packet included an unvalidated subjective questionnaire regarding the patient's perceived balance status and overall state of health as well as a copy of a validated (the Dizziness Handicap Inventory) questionnaire evaluating balance function (Appendix I).

The unvalidated portion of the questionnaire included both closed and open questions. The closed questions required patients to select an answer from a given list of possible choices.

The closed set choices were scored as follows: poor (score=1), fair (score=2), average (score=3), good (score=4), and excellent (score=5). The open questions allowed patients to answer questions in their own words.

The validated portion of the questionnaire was the Dizziness Handicap Inventory (DHI). The DHI consists of 25 questions divided into three categories: functional, emotional, and physical. There are three response options for each question "yes," "no," and "sometimes." The scoring for all of the questions is as follows: A "yes" response is scored 4 points, a "no" response is scored 0 points, and a "sometimes" response is scored 2 points. "Thus, possible scores on the total subscale range from 0, suggesting no handicap, to 100, indicating significant self-perceived handicap" (Jacobson et al., 1990).

The DHI questionnaire was modeled after the Hearing Handicap Inventory for the Elderly (Jacobson et al., 1990). Jacobson et al. (1990) states, "The 25-item Dizziness Handicap Inventory (DHI) was developed to evaluate the self-perceived handicapping effects imposed by vestibular system disease."

Developers proposed that the DHI would fill a void in conventional diagnostic tests, which were not adequate for evaluating the handicapping effects of vestibular disorders. Jacobson et al. (1990) states, "Dizziness is one of the few disease symptoms that is capable of causing patients to modify their lives even in its absence. Thus, it is a common clinical observation that intermittent dizziness often effects changes in a patient's daily activities even during time of remission. For example, individuals may restrict their driving habits or social activities in fear of a dizziness attack." Conversely, results of the DHI could also reveal a patient population that has constant dizziness and do not consider themselves to be handicapped by the condition (Jacobson et al., 1990). Because of the possible inconsistencies in objective and subjective vestibular disorder measurements, conducting a patient perceived measure of handicap is an important part of understanding and treating a patient.

STATISTICAL TECHNIQUES

Statistical analysis of the data was performed using either T-tests or the McNemar test via the following website: http://vassun.vassar.edu/~lowry/VassarStats.html.

RESULTS

GROUP COMPOSITION

A complete set of useable questionnaires was returned by 31 (response rate of 51.7%) of the 60 patients. Of the 31 questionnaires returned, 16 (51.6%) were from the microsurgery group and 15 (48.4%) were from the gamma knife group. For the patients who returned questionnaires, medical charts were reviewed to obtain additional information regarding sex, age at time of treatment, time since treatment, and size of tumor.

DEMOGRAPHICS

For the microsurgical group there were ten (62.5 %) males and six (37.5 %) females. The age of the microsurgical group ranged from 31 to 67, with a mean age of 52 years (SD= 9.6). The median age was 54 years. Figure 1 below displays the microsurgical patient age distribution.

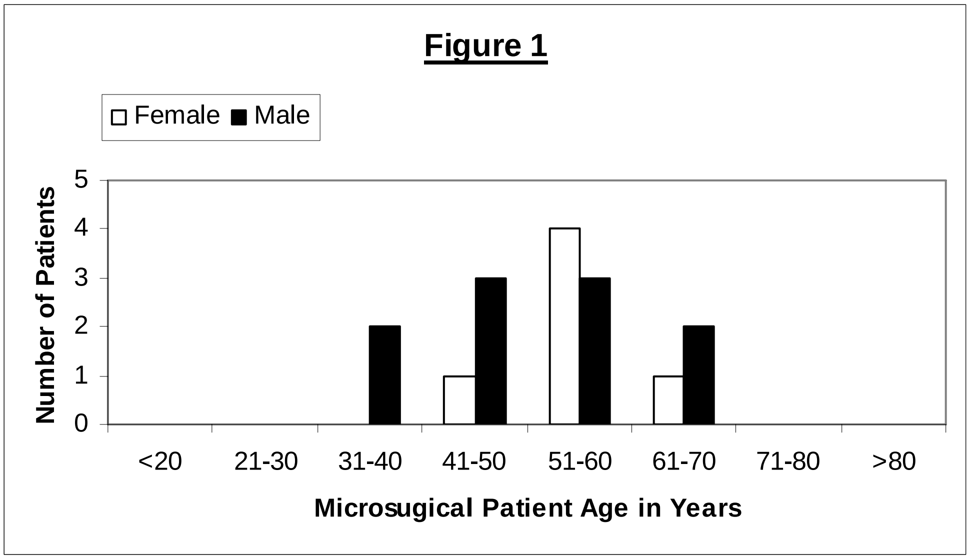

Figure 1. Age distribution of microsurgical respondents by gender. The white bar represents female respondents in the microsurgical study group. The black bar represents male respondents in the microsurgical study group.

For the gamma knife group there were ten (66.7 %) males and five (33.3 %) females. The age of the gamma knife group ranged from 18 to 77, with a mean age of 59 years (SD= 14.5.). The median age was 62 years. Figure 2 below displays the gamma knife patient age distribution.

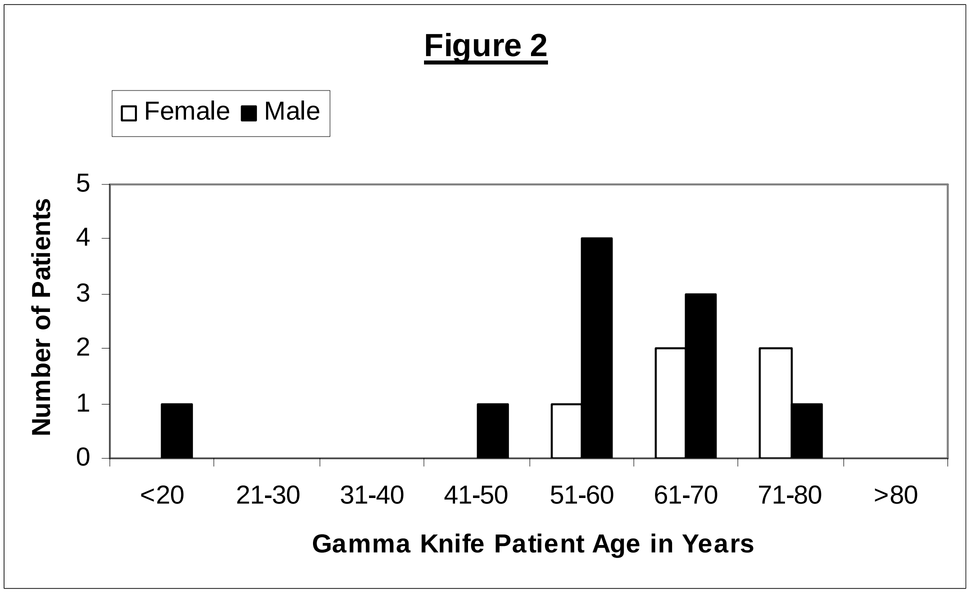

Figure 2. Age distribution of gamma knife respondents by gender. The white bar represents female respondents in the gamma knife study group. The black bar represents male respondents in the gamma knife study group.

A t-test revealed no significant difference between the ages of the microsurgery and gamma knife study groups (P = .089).

CLINICAL CONDITIONS

For the microsurgical study group the tumors ranged from 0.6 to 4.0 cm, with a mean size of 1.9 cm (SD = .93). The mean tumor size was Grade 2. The median size of microsurgical study group's tumors was 1.7 cm. For the gamma knife study group the tumors ranged from 1.1 to 2.6cm, with a mean size of 1.5 cm (SD = .46). The mean tumor size was Grade 3. The median size of gamma knife study group's tumors was 1.5 cm. A t-test revealed no significant difference between the tumor size of the study groups (P = .137). Figure 3 below represents the mean size of tumors in each study group.

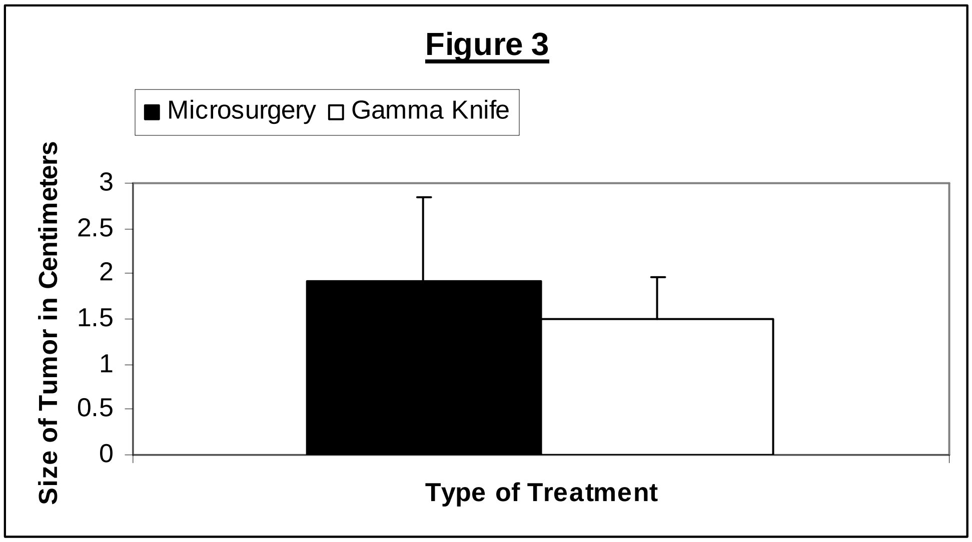

Figure 3. Mean diameter of tumor in each study group. The black bar represents the microsurgery study group. The white bar represents the gamma knife study group. The error bars represent the standard deviation from the mean.

Patients from the microsurgical group were a mean of 1.6 years post-treatment (range, 0.5 to 3.5 years; SD=.88). The median was 1.5 years. Likewise, patients from the gamma knife group were also a mean of 1.6 years post-treatment (range, 0.5 to 3 years; SD = .99). The median was 1.75 years. A t-test revealed no significant difference in the time since treatment between the microsurgical and gamma knife study groups (P = .827). Figure 4 below is a graphic representation of the mean number of years for each study group.

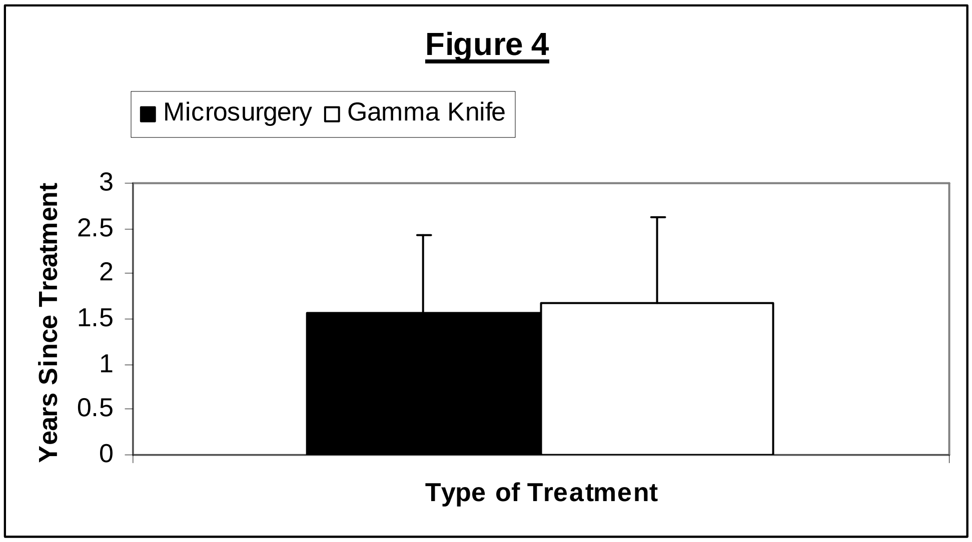

Figure 5. Mean number of years since patient underwent treatment modality. The black bar represents patients in the microsurgery study group. The white bar represents patients in the gamma knife study group. The error bars represent the standard deviation from the mean.

GENERAL HEALTH STATUS

For the microsurgical group patient perception of overall health now had responses in all possible categories (Poor, Fair, Average, Good, and Excellent). The mean score for this group was 3.75 (SD=1.13). The gamma knife group had responses in four of the five possible categories (Fair, Average, Good, and Excellent). The mean score for this group was 3.87 (SD=.99). A t-test of the data revealed no significant difference between groups for the status overall health now. This suggests patients in both groups generally feel the same about their current health.

For the microsurgical group patient perception of overall health prior to excision again had responses in all possible categories. The mean score for this group was 3.69 (SD=1.35). The gamma knife group had responses in all of the five possible categories. The mean score for this group was 3.67 (SD=1.23). A t-test of the data revealed no significant difference between groups for the overall status of health prior to treatment. This suggests patients in both groups generally feel the same about their health before they underwent treatment.

Next, patient opinion of how their overall health will be in five years was assessed. This section of the questionnaire was an open question. For the microsurgical group 31.25% (n=5) of patients felt that in five years their health would be “Excellent.” 37.5% (n=6) of microsurgical patients felt that their health would be “Good.” 6.25% (n=1) of patients in this group responded their health would be “Average” in five years. 6.25% (n=1) of patients responded that they believe their health would be “Fair” in five years. 18.75% (n=3) of the microsurgical study group had hope for improvement in overall health status.

When the gamma knife study group was evaluated on the bases of perceived overall health in five years, 20% (n=3) of patients felt that in five years their health would be “Excellent.” 26.7% (n=4) of patients felt that their health would be “Good.” 13.3% (n=2) of patients in this group responded their health would be “Average” in five years. 6.7% (n=1) of patients responded that they believe their health would be “Fair” in five years. 6.7% (n=1) responded that they thought their health would be “Poor” in five years. 6.7% (n=1) of the gamma knife study group had hope for improvement in their overall health status. 6.7% (n=1) of the gamma knife study group replied they think their overall health status will be “The same to worse.” 13.3% (n=2) of gamma knife patients responded they were “Unsure” of what their overall health status would be in five years.

12 (75%) patients in the microsurgical group reported having dizziness prior to treatment. Four (25%) patients in this same group reported they did not have any dizziness prior to tumor excision. Nine (60%) patients in the gamma knife study group reported having dizziness prior to

treatment. Six (40%) patients in the gamma knife group reported they did not have any dizziness prior to radiosurgery.

Given these results, McNemar chi-square test was performed to analyze the relationship of pretreatment symptoms to post-treatment symptoms (if you have dizziness before treatment will you have dizziness afterwards). Table 1 and Table 2 below are the graphic representation of this analysis.

Table 1				
Microsurgery		Post-treatment Dizziness		
		Yes	**No**	**Sum**
Pretreatment Dizziness	**Yes**	9	3	12
	No	3	1	4
	Sum	12	4	16

Table 1. McNemar chi-square test

For the microsurgical study group there was no significant difference (P=1.3) identified. These results suggest that for the given data there is no relationship between having dizziness before treatment and having dizziness afterwards due to microsurgery.

Table 2				
Gamma Knife		Post-treatment Dizziness		
		Yes	**No**	**Sum**
Pretreatment Dizziness	**Yes**	9	1	10
	No	1	4	5
	Sum	10	5	15

Table 2. McNemar chi-square test

Similarly, in the gamma knife group there was no significant difference (P=1.5) detected. Again, these results suggest that for the given data there is no relationship between having dizziness before treatment and having dizziness afterwards due to gamma knife treatment.

Patients were also asked to answer a question regarding dizziness in spells prior to their treatment. In the group who underwent microsurgical tumor excision there were six (37.5%) “Yes” responses and ten (62.5%) “No” responses. The results for patients who underwent gamma knife radiosurgery revealed four (26.7%) “Yes” responses, ten (66.7%) “No” responses, and one (6.7%) individual who did not answer the question.

Then the study groups were asked to answer a question regarding dizziness in spells after treatment. In the microsurgical group of respondents there were five (31.25%) “Yes” responses and eleven (68.75%) “No” responses. The results for patients who underwent gamma knife radiosurgery revealed six (40%) “Yes” responses, eight (53.3%) “No” responses, and one (6.7%) individual who did not answer the question.

Patients were also asked about dizziness or imbalance limiting their daily activities prior to treatment. The results from microsurgery study group showed seven (43.75%) patients who responded “Yes”, eight (50%) who responded “No”, and one (6.25%) who did not respond. The gamma knife patients had five (33.3%) “Yes” responses, nine (60%) “No” responses, and one (6.7%) who patient who did not answer.

Next patients where asked “Do you have dizziness or imbalance now that limits your daily activities?” The microsurgery study group had six (37.5%) patients who responded “Yes” and ten (62.5%) who responded “No.” The gamma knife patients had seven (47%) “Yes” responses and eight (53%) “No” responses. Many patients in both groups also noted that climbing stairs, walking, and maneuvering in darkness are problematic. Patients stated they try to avoid or require help when in these situations.

Another section of the questionnaire that was an open question was "Would you choose the same treatment again?" For the microsurgery study group 12 (75%) answered "Yes", one (6.25%) patient answered "No", two (12.5%) answered "Not sure" and one (6.25%) patient responded "No comment." For the gamma knife study group 12 (80%) answered "Yes" when asked if they would repeat the same treatment again, 1 (6.7%) patient answered "No", one (6.7%) patient answered "Not sure", and one patient (6.7%) responded "Maybe not".

DHI RESULTS

The subsequently an analysis was done on the DHI score of both the microsurgery and gamma knife radiosurgery study groups. The scores were divided into the three domains: functional, emotional, or physical. In none of the three domains were any significant differences found between the two study groups. These results suggest that microsurgical and gamma knife patients do not have a divergence in their perceived dizziness handicap post-treatment. Figure 5 below, represents these data.

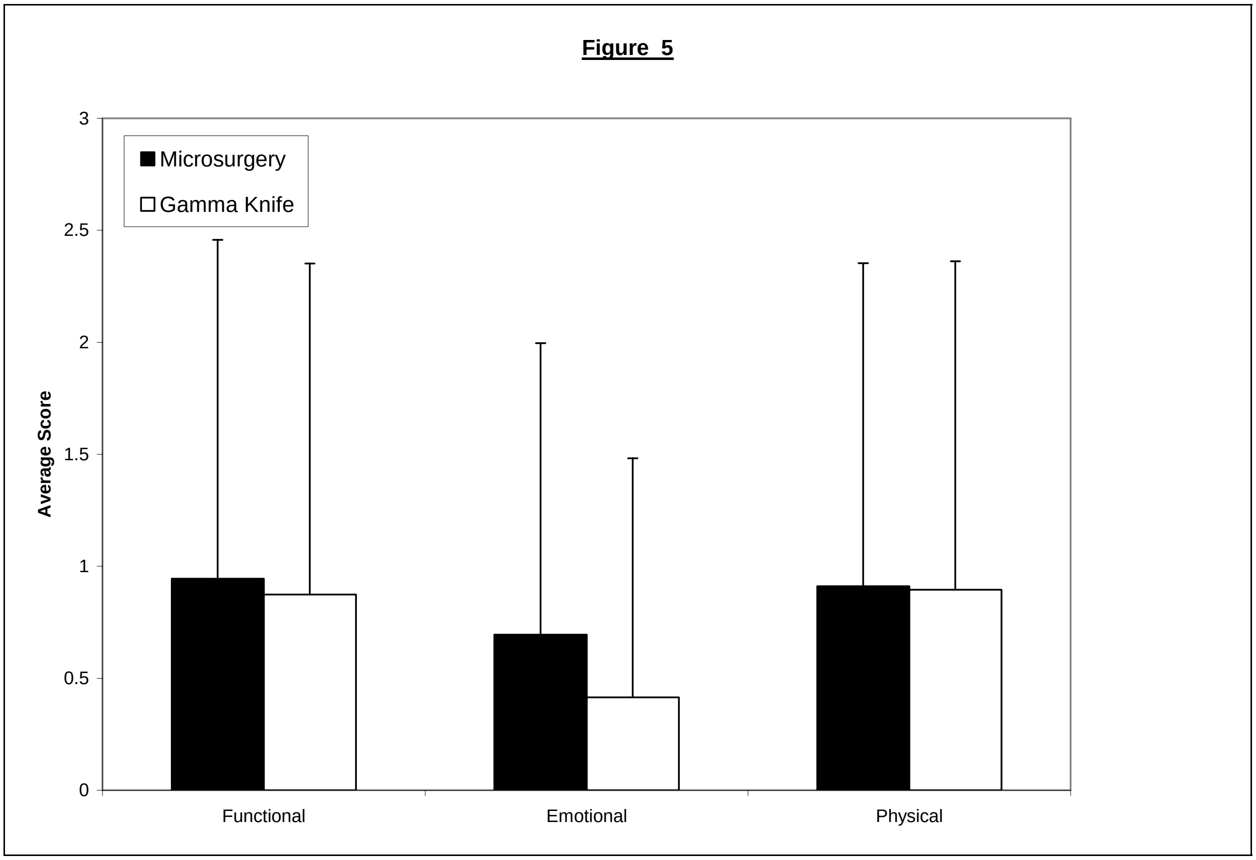

Figure 5. Average DHI functional, emotional, & physical scores of microsurgical and gamma knife patients. The black bar represents the microsurgery study group. The white bar represents the gamma knife study group. The error bars represent the standard deviation from the mean.

In the DHI portion of the questionnaire there were certain questions that showed patterns among responses. No one in either group answered “yes” to questions #1 (Does looking up increase your problem?), 7 (Because of your problem, do you have difficulty reading?), or 18 (Because of your problem, is it difficult for you to concentrate?). For question #22 (Has your problem placed stress on your relationships with members of your family or friends?) no one in the gamma knife group answered “yes.” No one in the microsurgery group answered yes to question #5 (Because of your problem, do you have difficulty getting into or out of bed?). Respondents in both groups frequently answered “yes” to questions #11 (Do quick movements of your head increase your problem?) and #12 (Because of your problem, do you avoid heights?). Questions #20 (Because of your problem, are you afraid to stay home alone?) and #21

(Because of your problem, do you feel handicapped?) only one had "yes" response from the gamma knife group.

DISCUSSION

Research on the subject of vestibular schwannoma outcome can better help physicians counsel and recommend appropriate management strategies. It is essential that physicians have this research data in order to inform patients about the vestibular outcome associated with each option. Studies like this one allow physicians and patients to be able to include the level of imbalance post-treatment into their decision making process.

The two groups involved in this study showed no statistical difference in their mean age. However, Figures 1 and 2 show a difference in the shape of the overall age distribution. The gamma knife study group (Figure 2) was composed of patients who were both younger and also older than anyone in the microsurgical study group (Figure 1). The microsurgery patients had slightly larger tumors than the gamma knife patients (Figure 3). However, the difference in size between groups was small and not significantly different. The general health between the microsurgical and gamma knife study groups was equal. The DHI scores of the two study groups were also equal. As a result, the two groups can still be compared.

Wiegand and Fickel (1989) studied patients who had undergone surgical tumor removal. These researchers found that 30% of the microsurgical patients involved in their study had dizziness that was "cured" or improved by surgery. This current study had two study groups (microsurgery and gamma knife radiosurgery). For the microsurgery group, three (25%) of the twelve patients who had dizziness prior to treatment did not have dizziness post-treatment (Table 1). This is similar to the 30% found in the Wiegand and Fickel (1989) study. For the gamma knife group, one (10%) of the 10 patients who had dizziness prior to treatment did not have dizziness post-treatment (Table 2). This suggests that perhaps gamma knife is not as therapeutic as microsurgery in terms of dizziness. This could be due to the individual goals of each treatment option. The goal of microsurgery is total tumor removal. The goal of gamma knife radiosurgery is to inhibit further tumor growth. Gamma knife patients still have a tumor present. Therefore, in cases where the patient's primary concern is "curing" dizziness, physicians and patients may want to choose microsurgery.

This study showed no relationship between having not having dizziness prior to treatment and having dizziness after treatment in either study group. This means that using this research data, physicians cannot indicate to their patients whether microsurgery or gamma knife radiosurgery will "cure" or exacerbate dizziness.

In summary, this study has shown that patients who undergone both microsurgical tumor removal and those who have undergone gamma knife radiosurgery for vestibular schwannoma have dizziness is a subsequent treatment morbidity. The investigation also shows that the two groups studied seem to have equal vestibular dysfunction. Neither group has more imbalance and nor does either group feels more handicapped by their post-treatment condition.

LIMITATIONS

One limitation of this study was the use of a retrospective questionnaire. This required patients to recall pretreatment vestibular function. In some cases this was more than three years prior to the actual administering of the questionnaire. Another weakness of the study was the setup of the overall health status portion of the questionnaire. This was evident because some of the respondents did not complete all items. Another major limitation was the small sample size (n=31 respondents). The sample size makes it difficult to generalize the results to the entire microsurgical and gamma knife patient populations.

Future studies should have larger sample sizes. Also studies should be prospective, so patients' vestibular status can be well established before and after treatment. Researchers should also do both subjective (i.e. the DHI) and objective testing (i.e. calorics, rotary chair, head-trust sign, and posturography) to evaluate the vestibular function of patients.

Despite these limitations, this study does have clinical applications. Physicians can use the results to counsel patients on the outcomes of past patients and possibility what they can expect. The results of the study suggest patients who have vestibular schwannomas will have dizziness and imbalance following microsurgery and gamma knife radiosurgery.

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APPENDIX

Appendix I

General Questions:

(1) Please mark the box that best describes your overall level of health now.

☐Poor ☐Fair ☐Average ☐Good ☐Excellent

(2) Did you have dizziness or imbalance prior to your treatment?

Was it in spells? Did it limit your activity at any point?

(3) Have you had dizziness or imbalance at any time following your treatment?

Was it in spells? Did it limit your activity at any point?

(4) Do you have dizziness or imbalance now that limits your daily activities? If so, which activities does it limit (eg driving, walking without assistance)?

(5) Would you choose the same treatment again?

(6) Please mark the box that best describes your overall level of health prior to treatment.

☐Poor ☐Fair ☐Average ☐Good ☐Excellent

(7) How do you expect your health to be in 5 years from now?

<u>Dizziness Handicap Inventory:</u>

The purpose of these questions is to identify difficulties that you may be experiencing because of your dizziness. Please mark "*yes*", "*no*", or "*sometimes*" for each question. Answer each question as it pertains to your dizziness or balance problem since vestibular schwannoma treatment.

(1) Does looking up increase your problem?

☐Yes ☐No ☐Sometimes

(2) Because of your problem, do you feel frustrated?

☐Yes ☐No ☐Sometimes

(3) Because of your problem, do you restrict your travel for business or recreation?

☐Yes ☐No ☐Sometimes

(4) Does walking down the aisle of a supermarket increase your problem?

☐Yes ☐No ☐Sometimes

(5) Because of your problem, do you have difficulty getting into or out of bed?

☐Yes ☐No ☐Sometimes

(6) Does your problem significantly restrict your participation in social activities such as going out to dinner, going to movies, dancing, or to parties?

☐Yes ☐No ☐Sometimes

(7) Because of your problem, do you have difficulty reading?

☐Yes ☐No ☐Sometimes

(8) Does performing more ambitious activities like sports, dancing, household chores such as sweeping or putting dishes away increase your problem?

☐Yes ☐No ☐Sometimes

(9) Because of your problem, are you afraid to leave your home without having some one accompany you?

☐Yes ☐No ☐Sometimes

(10) Because of your problem, have you been embarrassed in front of others?

☐Yes ☐No ☐Sometimes

(11) Do quick movements of your head increase your problem?

☐Yes ☐No ☐Sometimes

(12) Because of your problem, do you avoid heights?

☐Yes ☐No ☐Sometimes

(13) Does turning over in bed increase your problem?

☐Yes ☐No ☐Sometimes

(14) Because of your problem, is it difficult for you to do strenuous housework or yardwork?

☐Yes ☐No ☐Sometimes

(15) Because of your problem, are you afraid people may think you are intoxicated?

☐Yes ☐No ☐Sometimes

(16) Because of your problem, is it difficult for you to walk by yourself?

☐Yes ☐No ☐Sometimes

(17) Does walking down a sidewalk increase your problem?

☐Yes ☐No ☐Sometimes

(18) Because of your problem, is it difficult for you to concentrate?

☐Yes ☐No ☐Sometimes

(19) Because of your problem, is it difficult for you to walk around your house in the dark?

☐Yes ☐No ☐Sometimes

(20) Because of your problem, are you afraid to stay home alone?

☐Yes ☐No ☐Sometimes

(21) Because of your problem, do you feel handicapped?

☐Yes ☐No ☐Sometimes

(22) Has your problem placed stress on your relationships with members of your family or friends?

☐Yes ☐No ☐Sometimes

(23) Because of your problem, are you depressed?

☐Yes ☐No ☐Sometimes

(24) Does your problem interfere with your job or household responsibilities?

☐Yes ☐No ☐Sometimes

(25) Does bending over increase your problem?

☐Yes ☐No ☐Sometimes