Hearing after Gamma Knife surgery

DOUGLAS KONDZIOLKA, M.D.

Department of Neurological Surgery, University of Pittsburgh, Pennsylvania

Yomo and colleagues\(^4\) review the extensive vestibular schwannoma (VS) experience from Marseille. They paid special attention to the longitudinal audiometric data both before and after Gamma Knife surgery (GKS) in 154 patients with unilateral VS over an 8-year period. Their hypothesis was that radiosurgery would worsen the expected rate of hearing deterioration in a patient with VS in comparison with the natural course. Recently, there have been a number of articles on conservative management for VS that have included analyses of hearing loss. A recent report from the Marseille group compared radiosurgery outcomes to observation in patients with intracanalicular tumors and found that failure (tumor growth plus or minus hearing loss) was worse in the patients who were observed.\(^3\)

In the present analysis, Yomo and colleagues found that the annual hearing reduction was 5.39 dB/year before radiosurgery and 3.77 dB/year afterward. The data were collected over a mean of 22 and 52 months, respectively.

A cochlear dose of less than 4 Gy was found to be important for hearing preservation. The authors noted a trend toward reduction in the annual hearing loss after radiosurgery but called for more clinical information to identify a possible protective effect of radiosurgery for hearing. It is important to note that their radiosurgical technique was excellent and included use of stereotactic frame-based GKS, careful anatomical dose delineation of the tumor and regional structures, and precise tumor dose delivery. Radiosurgery was followed by meticulous serial assessments.

Why does hearing loss occur in the setting of VS? In the natural state, one may hypothesize that effects on cochlear nerve axons due to local compression, invasion, or ischemia may be important. Certainly, tumor volume correlates with hearing function at presentation, although the extent of the tumor in the auditory canal is also important. Patients with larger tumors who have only a small component within the canal may maintain excellent hearing. Hearing loss after radiosurgery may be due to additional mechanisms. Radiation may affect axonal physiology or the function of the cochlea, causing them to be different from the pretreatment state. In addition, the induced tumor injury is mediated through acute and later chronic inflammation, which in some patients can lead to a transient expansion of the tumor capsule and release of cytokines. These changes may affect hearing. Although tumors usually regress over time, transient intratumoral changes may have permanent effects on hearing. In the background of this analysis, the authors importantly point out the simple effects of aging on hearing. An annual hearing loss of 1 dB per year continues to occur in the background of the tumor and its treatment. Perhaps as important a conclusion as any other in the report is the need for long-term evaluations of hearing, since short-term analyses tend to overstate the rates of hearing preservation. Prior reports with a mean duration of follow-up of even less than 1 year have been published with conclusions on hearing “preservation rates.”\(^2\) Longer-term analyses from the same institution showed lower rates.\(^2\)

In summary, there is much work to do to further our understanding of the physiology and pathology of hearing function and preservation in the setting of VS and the available management options. Twenty years ago hearing preservation was the “Holy Grail” of the VS story. Now it is an expected outcome for many patients. Recently, there has been some resurgence in interest for the wait-and-see strategy. Although this makes sense for the elderly, I believe that it is a lesser option for most patients. This important report will encourage other centers to obtain meticulous audiometric follow-up.

Disclosure

Dr. Kondziolka is a consultant for Elekta AB.

References


This article contains some figures that are displayed in color online but in black-and-white in the print edition.
We would like to thank Dr. Kondziolka for his editorial comments on our paper. The demonstrated high rate of long-term tumor control and motor facial nerve preservation achieved using radiosurgery, when practiced with high precision devices and experienced teams, has focused attention on hearing preservation in recent years. However, there is a major difference, frequently underestimated, between motor facial nerve preservation and hearing preservation, in terms of the natural history of VS. Indeed, the natural history of this condition is associated with a very low risk of motor facial palsy. Thus, any facial palsy after radiosurgery (0.7% in our series) is likely to be due to the radiosurgery itself, and the postoperative motor facial function must be presented as a rate of motor facial function injury. On the other hand, the majority of untreated patients will gradually lose the functionality of their hearing on the side of the tumor and some will lose hearing bilaterally due to presbycusis. Consequently, a number of the functional hearing losses occurring after radiosurgery are likely to be related to the natural history of the tumor, and thus long-term postoperative hearing results may be expressed as a rate of functional hearing spared by radiosurgery, compared to the rate of preserved hearing expected in untreated cases. In any case, the percentage of patients having lost the functionality of their hearing should not be reported as a rate of radiosurgery toxicity. This observation has led us to consider that technical improvements such as cochlear dose reduction might certainly reduce the number of patients with hearing loss, but we may not be able to achieve the very high rate of functional preservation that is possible with motor facial function. Careful reading of these papers, however, shows that hearing assessment was not based on pre- and postoperative tonal and vocal audiography, the gold standard method used in our center to evaluate hearing after radiosurgery. In fact, papers reporting long-term hearing outcome after stereotactic radiotherapy based on tonal and vocal audiography report rates of functional preservation of 56%–74%, with a mean follow-up of only 14.7–48 months, rates of functional preservation that are in the same range as hearing results following radiosurgery. As mentioned by Dr. Kondziolka, some previously impressive results from the same authors proved to be artifactual due to very short follow-up, as demonstrated, thanks to the seriousness of the authors, by further publication with longer-term follow-up.

In addition to the dose-planning–related predictors, it is also of the utmost importance to consider the major impact of numerous preoperative patient-related factors like patient age, history of sudden hearing loss, level of hearing before radiosurgery, and extent of the tumor within the canal. In our experience, the overall rate of functional hearing preservation at 3 years is 65%, rising to 90% in patients younger than 30 years, 78% in those with subnormal hearing whatever the age, 80% in those with tinnitus as a first symptom, and 95% in those with both subnormal hearing and tinnitus as initial symptoms. Thus, due to the huge influence of these factors, patient selection would appear to play a major role in the hearing preservation rate and must be taken into account when comparing series or techniques. Stratification based on these predictors should be mandatory for any serious evaluation of functional hearing preservation. Finally, radiosurgical series usually report hearing results for the overall population treated. Some techniques or surgical approaches are intended to maximize preservation of hearing and may be proposed only in optimal candidates (young patients, those with small lesions, excellent hearing, and so forth). Some centers propose radiosurgery for patients with no residual functional hearing and stereotactic radiotherapy for the others. Similarly some centers propose a translabyrinthine approach in patients with no residual functional hearing and a retrosigmoid or supratentorial approach in the others. In radiosurgical series focusing on the same population of “good candidates,” the rate of functional hearing preservation has been as high as 78.4%. Assessment of hearing preservation is obviously a complex matter! Thus, the fact that our paper (which compares a pragmatic “wait and see” approach with preoperative GKs) demonstrates a higher chance of functional preservation after GKS supports the notion that the hearing “toxicity” of radiosurgery is lower than the hearing loss associated with the natural history of the condition. However, this was not a prospective randomized study and some selection bias may alter the value of this study. Consequently, in patients followed with repeated audiography and then treated with GKS, the annual hearing decrease rate (AHDR) has been compared before and after radiosurgery. The fact that the decision to treat the patient was frequently based on tumor growth and/or deterioration of hearing is a major bias and may tend to play against the positive effects of radiosurgery in this study. In spite of this unfavorable factor of patient selection, the AHDR proves to be significantly reduced by radiosurgery especially after the first postoperative year (Fig. 1).
study would thus appear to confirm the overall feeling of most neurosurgeons with a large VS case load: radiosurgery may be a window of opportunity for patients presenting with VS in the context of preserved hearing.

We must also keep in mind that other symptoms such as poor balance, tinnitus, and impaired lacrimal function can significantly impact quality of life for these patients and must be part of our standard evaluation of postoperative outcome.\textsuperscript{3,4,5}\textsuperscript{11,12} In our opinion the debate about the improvement of hearing preservation rates must not overlook the importance of these other symptoms, which are also very much related to the natural history of VS.

References


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