Is Hearing Preserved Following Radiotherapy for Vestibular Schwannoma?

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BACKGROUND

A common question by patients with newly diagnosed vestibular schwannomas (VS) is, “Which treatment will best preserve my hearing?” Currently, management of this benign tumor arising from the eighth cranial nerve sheath includes three broad options: observation with serial imaging, microsurgery, and radiotherapy. There are no high-quality, prospective controlled trials comparing outcomes among these three treatment modalities. Therefore, treatment recommendations are largely based on data from single-institution case series. As outcomes of tumor control and facial nerve preservation have improved with modern surgical and radiotherapy techniques, the possibility of hearing preservation (HP) often plays a significant role for patients and physicians making treatment decisions.

The heterogeneity of data poses a major challenge to providing accurate estimates of hearing preservation rates with radiotherapy for VS. Indications for treatment and inclusion criteria vary widely by institution. Radiation may be delivered in a single dose or as many as 30. The radiation source may be cobalt (e.g., GammaKnife surgery [GKS]) or a linear accelerator (e.g., CyberKnife). The methods for reproducing localization differ between techniques as well. Moreover, hearing outcomes are not standardized. For example, some publications simply report the patient’s subjective ability to use the telephone at the first post-treatment visit, whereas other studies utilize audiograms to provide an objective measure of hearing in the treated ear. Traditionally, serviceable hearing has been defined as pure-tone audiometry (PTA) < 50 db with speech discrimination scores (SDS) > 50%, corresponding to American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) class A or B, or Garner-Robertson (GR) grade 1 or 2. These differences result in widely varied rates of hearing preservation (between 10% and 90%) after radiotherapy for VS.

LITERATURE REVIEW

Modern techniques for radiotherapy-based treatment of VS have improved significantly since the first publication of this technology for VS treatment in the 1970s in Sweden and the early 1990s in the United States. A high-quality systematic review of hearing preservation after GKS radiosurgery was published in 2010 by Yang.1 They examined 45 publications with 4,234 patients and calculated an overall hearing preservation rate, as defined by maintenance of AAO-HNS A/B or GR grade 1/2, of 51%. Doses ≤ 13 Gy were significantly associated with better hearing preservation. Tumor volume and patient age did not correlate with hearing preservation rates. The average follow-up time was 44.4 ± 32 months, with a median of 35 months. Importantly, this study only evaluated GKS and crude hearing preservation rates without examining time-based hearing preservation rates. Since this systematic review was published, there have been several new case series reporting long-term hearing preservation rates in patients treated with modern radiotherapy techniques.

Carlson and colleagues2 retrospectively examined 44 patients undergoing GKS with a median audiometric follow-up time of 9.3 years. Audiometry was evaluated using the AAO-HNS scale. The marginal dose was 12 Gy in 41 patients and 13 Gy in three patients. The authors performed 10-year Kaplan-Meier actuarial estimates of the percentage of patients maintaining class A/B hearing, which showed a progressive decline: 80%, 55%, 48%, 38%, and 23% at 1, 3, 5, 7, and 10 years following GKS, respectively. Anticipating some age-related hearing loss over a 10-year period, the authors attempted to account for this
by including an interaural correction and showed, in the
cruralateral ear, an 8.5-dB increase in PTA and a 1.8%
drop in SDS over the long follow-up course. Even after
accounting for this adjustment, the treated ear demon-
strated continued hearing loss throughout the course of
long-term follow-up. On multivariate analysis, they found
pretreatment PTA and tumor size were associated with
time to loss of class A/B hearing.

The University of Pittsburgh published their low-dose
GKS outcomes on 216 patients treated between 1992 and
2000.3 Marginal GKS doses were 12 Gy in 21 patients,
12.5 Gy in 11 patients, and 13 Gy in 184 patients. The
median follow-up was 68 months. Before radiosurgery,
106 patients had GR class 1 or GR class 2 hearing, with a
10-year actuarial hearing preservation rate of
44.5% ± 10.5%. Fifty-seven percent of these patients pre-
served GR 1/2 hearing at last follow-up. The authors also
noted a continued decline in hearing preservation rates as
time to follow-up increased, particularly beyond 6 years.
Multivariate analyses revealed treatment volume was sig-
ificantly correlated with a drop in hearing classification.

Rasmussen et al. evaluated 42 patients receiving
54 Gy of fractionated stereotactic radiotherapy (FSRT) in
27 to 30 fractions, with a median follow-up of 5 years. All
patients were prospectively followed with magnetic reso-
nance imaging and audiograms 1, 2, 3.5, 5, 7, and 10 years
after FSRT. Twenty-one of 42 patients had GR class 1
hearing before FSRT, of whom, eight (38%) retained GR
1/2 hearing 2 years posttreatment. Seven of these
patients were followed for 10 years; none retained GR 1/2
hearing 10 years after FSRT.

Roos et al.5 reviewed their experience with single-
dose, linear accelerator stereotactic radiosurgery. Although
they lacked speech discrimination scoring, they
reported HP rates relative to interaural PTA differences in
50 patients with pretreatment hearing <50 dB PTA.
Patients were followed for a median of 65 months, and
similarly showed a significant relative decline in the ipsi-
lateral serviceable hearing preservation rate. The
Kaplan-Meier actuarial estimates of HP were 50% at
5 years and 23% at 10 years. Initial PTA was a significant
factor associated with hearing preservation.

Although there is heterogeneity of the methodolo-
gies, there is reliable evidence demonstrating that with
long-term audiometric follow-up, there is a continued
decline in hearing preservation rate, with remarkable
agreement of HP rates in the long-term case series (Fig. 1).
Initial pretreatment hearing class, tumor size, and
cochlear dose appear to affect the hearing preserva-
tion rates. There is a lack of high-level evidence to sup-
port differences in hearing preservation based on
radiotherapy equipment or fractionation technique.

BEST PRACTICE

The level of evidence of reviewed articles is low. Given
that the field involves rapidly developing technology, this

is not surprising. Moreover, synthesis of data from case
series is vitally important, as controlled studies comparing
radiotherapy against microsurgery or conservative man-
agement would logistically be very challenging. Evidence
from modern, highly conformal, low-dose radiation tech-
niques demonstrate that long-term hearing preservation
rates are poor; an approximately 80% hearing preservation
rate at 2 years posttreatment falls to approximately 23%
at 10 years. Although radiation therapy provides patients
with satisfactory short-term hearing preservation, this
treatment modality does not reliably preserve hearing in
the long term. It is important when assessing publications
in this field to thoroughly scrutinize the methodology, sys-
tems of hearing classification, and time to follow-up to pro-
vide patients with the most accurate estimations of
hearing preservation.

LEVEL OF EVIDENCE

Our review included one systematic review of case
series and four individual case series (level 4).

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