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Headache: A Quality of Life Analysis in a Cohort of 1,657 Patients Undergoing Acoustic Neuroma Surgery, Results from the Acoustic Neuroma Association

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Objectives: **On the basis of survey results of the Acoustic Neuroma Association (ANA), we report patient ratings of postoperative headache (POH) symptoms, determine its effect on quality of life (QOL), and review the literature regarding POH after acoustic neuroma (AN) treatment.** ***Study Design:*** **In this cohort study, 1,657 patients who underwent surgical treatment of AN reported their experiences of POH.** ***Methods:*** **A detailed questionnaire was mailed to members of the ANA to identify preoperative and postoperative headache symptoms, complications, and long-term effects on physical and psychosocial function. Questions were answered by 1657 (85.4%) respondents that were intended to qualify and quantify the effects of POH, including QOL issues. Responses were analyzed by tumor size, surgical approach, and patient age and sex. Statistical analysis was performed with the SPSS software.** ***Results:*** **Preoperative headache was reported in approximately one third of respondents. Typical POHs occurred more than once daily (46%), lasted 1 to 4 hours in duration (43.1%), and were of moderate intensity (62.6%). The worst headaches were rated as "severe" by 77% of respondents. Treatment most often reported for typical headaches were nonprescription medications including nonsteroidal anti-inflammatory drugs in 61.3% ($P < .01$) and regular use of narcotics in 15%. Patients who underwent the retrosigmoid approach were significantly more likely to report their worst POH as "severe" (82.3%) compared with the translabyrinthine (75.2%) and middle fossa approaches (63.3%). Women and younger patients tended to have poorer outcomes with regard to POHs.** ***Conclusions:*** **In this large cohort study of AN patients, POH was a significant morbidity among AN patients with persistent headaches. Treating physicians should be aware of the risk factors identified and the effect POH has on the QOL when counseling patients regarding optimal treatment management.**
Key Words: **Acoustic neuroma, Acoustic Neuroma Association, postoperative headache, preoperative headache, quality of life.**

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INTRODUCTION

Advances in the management of acoustic neuromas have reduced both mortality and morbidities (e.g., facial nerve paralysis, cerebrospinal fluid leak, meningitis). Head pain is expected in most patients immediately after acoustic neuroma surgery because of the incision, variations in cerebrospinal fluid pressure, muscle pain, or even meningitic pain. Headache that persists weeks to months after surgery is a morbidity that can be incapacitating. The exact prevalence and causes of persistent postoperative headache (POH) or postcraniotomy headache syndrome are elusive.[1,2] After surgical treatment of acoustic neuroma, the reported incidence of headache has ranged from 0% to 73% (Table I) depending on the type of surgical approach, technique used, and interval since surgery.[3–7] Frequent and severe POHs have been more often associated with the suboccipital or retrosigmoid approaches than the translabyrinthine or middle fossa approaches.[3,5,8]

Previous studies of POH after acoustic neuroma surgery have been retrospective case reviews based on chart reviews or telephone interviews and surveys mailed to small patient populations (Table I). Chart reviews often spanned many years and lacked detailed data regarding headache symptoms. Few studies have queried patients specifically about preoperative headache[1,2,4,5,9–12] and its relationship to POH factors (onset of worsening headache, frequency, duration, pain management with medication, and resolution).[4,5,9–12] Many of these studies included fewer than 150 patients, of whom less than half experienced persistent POHs, and often lacked a statistical analysis of POH and

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TABLE I.
Literature Review of Patients with Persistent POH after Acoustic Neuroma Surgery (with permission from Mayfield Clinic).

	Patients with or without POH (n)			Incidence of POH at Various Intervals Postoperatively (%)					
Author, Year	TL	RS	MF	3 months	6 months	12 months	2 years	3 years	Notes
Schessel, 1992	40	58		RS-64 TL-0					Telephone interview custom survey
Parving et al 1992	273			14					
Glasscock 1993		147	15	RS-22 MF-0					
Harner et al. 1993		331		23		16			
Pedrosa et al. 1994	15	135		RS-73 TL-53					
Catalano et al. 1996		84		51 (all) 30*					Semi prospective study
Ruckenstein et al 1996	18	35			RS-26* TL-6*	RS-17* TL-13*			*Incidences for patients with severe headaches only
Weber et al. 1996		64		1					
Wazen et al 2000		60		43					Limited POH questions compare craniotomy with cranioplasty
Jackson et al 2000		183		54 (all)	70†	44†	21†		Compared AN surgery to vestibular nerve section
Schaller et al. 2003		155		33%	22%	6.4%	5.8%		
Current series all patients	963	527	106	TL‡ MF‡ RS‡	84 78 93	76.8 71.5 82.7	72.5 60.8 75.6	66.9 53.7 71.1	64 50 66.2	Statistically significant MF compared with RS and TL
Current series "severe" worst headache only	277	216	18	TL MF RS	89 94 95	83 83 86	79 67 79	72 55 75	68 55 70.4	Percentages for worst "severe" POH

All percentages pertain to overall study population; select groups are noted when available (e.g. only severe POH patients).
*Incidences for patients with severe headaches only.
†Incidences for 24 patients with severe headaches only.
‡Incidences for 679 patients with *any degree* of POH beyond 3 months.
TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; POH = postoperative headache.

preoperatively known factors (sex, age, tumor size, presence of baseline preoperative headache). Most queried the patients about symptoms at a single time interval postsurgery (e.g., 3 months). Thus, determination of the natural history of persistent POH symptoms from the literature is difficult.

On the basis of the responses from a survey to members of the Acoustic Neuroma Association (ANA), we analyzed quantitative (i.e., frequency, duration, time to resolution) and qualitative measures (i.e., ability to work, effect) of POH and its impact on the quality of life (QOL).

MATERIALS AND METHODS

In 1998, the ANA mailed a questionnaire of 234 closed-answer items to 2,372 members to identify pre- and postoperative symptoms, surgical complications, long-term effects on physical and psychosocial function, and pre- and postoperative headache (Fig. 1). Previously, the questionnaire had been piloted among a small group of ANA members; its results were largely supported by POH studies reported in the literature.[1,3,4,8,13] Of 1,940 (81.8%) respondents, 1,875 (96.6%) reported they had underwent treatment for acoustic neuroma, 24 (1.2%) for meningioma, 11 (0.6%) for facial neuroma, and 16 (0.8%) for other tumors; 14 (0.7%) either gave multiple responses or did not respond. Of the 1,875 patients who had acoustic neuromas, 1,657 (88.4%) patients underwent surgical treatment, 90 (4.8%) underwent radiosurgery, 81 (4.2%) were observed, and 47 (2.8%) gave no answer.

Approximately 700 of the 1,657 patients who underwent surgical treatment for acoustic neuromas suffered from POHs. Our analysis focused on the responses of these ANA headache sufferers who may not reflect the average acoustic neuroma population. Reported percentages relate to valid single responses for each question and exclude multiple or no responses. Questions related to headache included preoperative headache; onset and status (temporary or permanent) of worsening headache after therapy; frequency, duration, intensity, and treatment required for POH; and resulting disability. Respondents rated the overall degree that they were affected by POH as a measure of effect on QOL.

Statistical Analysis

Responses were stratified by patient sex and age, tumor size, and surgical approach. The Pearson chi-square test for independence was used to determine statistical significance ($P \leq .05$ unless stated otherwise). Statistical analysis was performed with the SPSS 11.0 data analysis program (SPSS Inc. Chicago, IL). Log linear regression analysis was performed with SAS version 8 with the PROC CAT module (Carey, NC).

RESULTS

Demographics

Of 1,657 patients who underwent surgical treatment of acoustic neuromas, 547 (33%) were men, and 1,095

Describe your headaches

*Did you **suffer from headaches after your hospital stay that could not be attributed to post-surgery discomfort?*** Regardless whether they have stopped or not, please complete the box below.
If you did not suffer from headaches, please go to the next section.

1. When did they begin? **(Check only one)**
__ 1) < 1 month after treatment
__ 2) 1-2 months after treatment
__ 3) 3-6 months after treatment
__ 4) > 6 months after treatment

2. When did they stop? **(Check only one)**
__ 1) Within 12 weeks of onset
__ 2) Within 1 year of onset
__ 3) 1 to 2 years of onset
__ 4) 2 to 3 years of onset
__ 5) >3 years after onset
__ 6) Still ongoing at the same level
__ 7) Still ongoing but not as bad

3. What was (or is) the frequency of your *typical* headache? **(Check only one)**
__ 1) > 1/day
__ 2) > 1/per week
__ 3) < 1/week

4. What was (or is) the duration of your ***typical*** headache? **(Check only one)**
__ 1) >4 hours
__ 2) 1 to 4 hours
__ 3) <1 hour

5. What was (or is) the intensity of your typical headache? **(Circle one)**
Mild ----------Severe
1 2 3 4 5 6 7 8 9 10

6. What was (or is) the intensity of your worst headache? **(Circle one)**
Mild ----------Severe
1 2 3 4 5 6 7 8 9 10

7. What was (or is) the usual treatment for a *typical* headache? **(Check only one)**
__ 1) Narcotic required regularly
__ 2) Narcotic required only on occasion
__ 3) Non-prescription medication only
__ 4) No medications needed

8. What was (or is) your disability during a *typical* headache episode? **(Check only one)**
__ 1) Able to continue to work
__ 2) Unable to continue to work

Fig. 1. Headache survey questions (reprinted with permission from the Acoustic Neuroma Association).

(66%) were women, ranging in age from 13 to 89 (mean 58) years. We divided patients into four age groups: 40 years or less (n = 168), 41 to 55 years (n = 545), 56 to 75 years (n = 790), or older than 75 years old (n = 135). Tumor size was small (<1.5 cm) in 323 (21.1%) patients, medium (1.5–2.5 cm) in 602 (39.4%) patients, or large (>2.5 cm) in 604 (39.5%) patients. Surgical approaches included the translabyrinthine in 963 (58.1%) patients, retrosigmoid in 527 (31.8%), and middle fossa in 106 (6.4%). The mean interval between surgery and completion of the survey was 8 years; 348 (21%) patients completed the survey within 2 years of surgery.

Intervariable Dependence for Sex, Age, Tumor Size, and Approach

Independent variables (i.e., sex, age, tumor size, surgical approach) used to stratify responses were checked for intervariable dependence by log linear regression analysis. Patient sex did not significantly relate to age, tumor size, or surgical approach. However, slightly more men than women underwent middle fossa approaches. An expected relationship was found between tumor size and surgical approach. Middle fossa surgeries were performed typically for small tumors (51.5%), whereas both the retrosigmoid and translabyrinthine approaches had similar distributions for small, medium, and large tumors (approximately 20%, 40%, and 40%, respectively). A small statistically significant relationship was found for age and surgical approach. That is, as patient age increased, the translabyrinthine approach was performed more often, and the retrosigmoid approach was performed less often. In this patient cohort, the incidence of large tumors in patients 40 years or younger was 51% and 32% to 38% in other age groups.

Postoperative Headache Symptoms, Treatment, and Impact

Using log linear regression analysis, we found several statistically significant relationships between these listed measures of POH when stratified by patient factors, which we first grouped for each POH measure and then summarized according to these factors. Of the nearly 700 (41%) who responded to questions pertaining to POH (Fig. 1) (Tables III to XII "All Patients" column), typical headaches occurred more than once daily (46%), lasted 1 to 4 hours (43.1%), and were of "moderate" intensity (62.6%). The worst headaches were rated as "severe" by 77% of respondents. Treatments for typical headaches were nonprescription medicines (e.g., nonsteroidal anti-inflammatory drugs [NSAIDS]) in 61.3% ($P < .01$) and narcotic medication in 15%; distributions were similar for age, tumor size, surgical approach, and sex. Most patients were able to work during a typical headache and were evenly distributed for age, tumor size, and sex. Patients were half as likely to report being able to work after a retrosigmoid approach, as were patients after translabyrinthine and middle fossa.

Stratification by Patient Factors (Sex, Age, Tumor Size, Surgical Approach)

Preoperative headache. Four hundred fifty-eight (33.4%) of 1,375 respondents reported preoperative headaches (Table II). Twenty-six percent were men, and 37.1% were women ($P < .001$). Thus, men were affected 40% less often than women (odds ratio [OR] = 0.6). Two hundred ninety-four (64%) patients reported preoperative head-

TABLE II.
Experienced Preoperative Headache.

Preoperative HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	1,375	444	920	146	460	657	100	796	445	85	262	508	504
Yes	33.4	26.4	37.1	37.7	35.4	31.7	31	33.4	33.7	23.5	22.9	31.5	41.3
No	66.6	73.6	62.9	62.3	64.6	68.3	69	66.6	66.3	76.5	77.1	68.5	58.7

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

TABLE III.
Status of Worsening Postoperative Headache.

	Patients			Ages				Approach			Tumor Size		
Status POH	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	517	146	368	78	237	182	17	261	217	25	115	209	163
Temp	54.2	54.1	54.3	52.6	54.9	51.6	82.4	54.4	52.5	68	49.6	54.5	55.8
Permanent	45.8	45.9	45.7	47.4	45.1	48.4	17.6	45.6	47.5	32	50.4	45.5	44.2

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; POH = postoperative headache.

aches that 1asted 1 month to 28 years (mean 30 months). Preoperative headaches frequencies were 22.9% for small tumors, 31.5% medium tumors, and 41.3% large tumors ($P < .001$) and affected approximately one third of patients in each age group. No statistically significant relationships were found between preoperative headache and either age or surgical approach.

Preoperative headache as a predictor of POH. We performed a subanalysis to determine whether preoperative headache as an independent known variable could be predictive of POH factors. Logistic regression was used to relate the presence or absence of preoperative headache to some POH features, specifically start time, resolution time, frequency, duration, and intensity of typical and worst POHs, usual treatment, and ability to work. Results were adjusted for sex and size of tumor, which were shown to be related to preoperative headache. The frequency of POH was 40% more likely to be greater than once per day than less than once per week when preoperative headache was present (OR = 1.4, $P < .01$). Thus, the only significant relationship found was that patients with preoperative headache had more multiple occurrences of POH daily.

Temporary versus permanent headache. For 517 respondents, 54.2% felt that the POH was temporary (Table III). Distributions were essentially the same for all tumor sizes, sex, age, and surgical approaches.

Onset of worsening headaches. Among 694 patients who reported onset of worsening POH headaches, 373 (56.2%) developed in the hospital, 181 (27.3%) within 6 months postoperatively, and in 16.5% more than 6 months postoperatively. No statistically significant relationships were found for onset of worsening headache (no chart data). POHs developed within the first month in 521 (75%) patients regardless of sex, age, tumor size, or surgical approach (Table IV).

Resolution of postoperative headache. In our review of the literature, we found no clear definition of when surgically induced POH was considered persistent but found some studies typically described persistent POH after 12 weeks (Table I). Of 692 respondents, 609 (88%, or 36.7% of the entire study population) had POHs lasting beyond 12 weeks. Respondents reported resolution of POH from 12 weeks to more than 3 years later. If respondents had persistent headaches at the time of this survey, they rated whether it had improved or remained the same. Analysis was separate for POH with and without a finite resolution. Significant relationships were noted between time until headache resolution and surgical approach. At the time of survey, the following respondents had POHs: 64% of translabyrinthine, 66% of retrosigmoid, and 50% of middle fossa approaches. Of those with persistent but improving POHs, 80% were after retrosigmoid approaches, 71% translabyrinthine, and 43% middle fossa approaches.

Of those that resolved within 3 years, 70% of translabyrinthine, 60% retrosigmoid, and 61% of middle fossa resolved within 1 year (no statistical difference). When POH resolved within 1 year, resolution within 12 weeks occurred more often after translabyrinthine approaches than after retrosigmoid approaches (48.4% vs. 23.4%, respectively) ($P < .05$). Resolution within 12 weeks occurred ($P = .024$) more often in men (18.4%, n = 40) than women (9.6%, n = 45). Time of resolution did not depend on tumor size or age (Table V).

Duration and frequency of postoperative headaches. POH typically lasted less than 1 hour in patients 70 years and older and lasted more than 4 hours in patients 41 to 55 years (Table VI). For the 46% of all respondents who reported that POHs occurred more than once daily, distributions were similar for sex, age, tumor size,

TABLE IV.
Start Time of Worsening Postoperative Headache.

	Patients			Ages				Approach			Tumor Size		
Start Time of Worsened POH	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	694	221	469	91	289	279	30	376	265	30	159	280	216
<1 months	75.1	78.7	73.6	80.2	74.4	76	63.3	76.6	74	66.7	74.2	76.4	75.5
1–2 months	9.4	9.6	9.4	9.9	10.4	7.2	16.7	7.7	10.2	16.7	10.1	8.9	8.3
3–6 months	8.9	9.8	8.8	7.7	10.4	8.2	3.3	7.7	11.3	6.7	9.4	10	7.4
>6 months	6.6	7.0	6.5	2.2	4.8	8.6	16.7	8.0	4.5	10	6.3	4.6	8.8

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa.

TABLE V.
Time Until Worsening Postoperative Headache Resolved.

Resolution of Worsened HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	692	217	471	91	288	278	30	375	266	28	159	278	216
<12 weeks	12.3	18.4	9.6	13.2	11.8	12.2	13.3	16	6.8	21.4	8.2	15.1	12
<1 year	8.4	6.5	9.1	7.7	7.3	8.3	20	7.2	10.5	7.1	5.0	10.1	8.8
1–2 years	6.1	6.0	6.2	1.1	6.3	8.3		4.3	7.1	10.7	9.4	5.0	5.1
2–3 years	5.2	6.9	4.2	4.4	5.6	4.3	10	5.6	4.5	7.1	5.7	6.8	2.8
>3 years	3.9	3.2	4.2	2.2	4.2	4.3	3.3	2.9	4.9	3.6	3.1	4.7	3.2
Ongoing same	16.5	15.2	17.2	11	18.4	16.9	13.3	18.4	13.5	28.6	15.7	14.7	17.6
Ongoing better	47.7	43.8	49.5	60.4	46.5	45.7	40	45.6	52.6	21.4	52.8	43.5	50.5

The percentages in this table are 100% including both POH that resolved and that had not. The percentages in the body of the text are based on analysis of the resolution times separately for POH that resolved or did not.
TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

and surgical approach (Table VII). When preoperative headache was present, POH frequency was 40% more likely to occur greater than once per day (or >7 per week) than less than once per week (OR = 1.4, $P < .01$)

Intensity of postoperative headaches. Although some authors use the Harner 4-point scale (3 and 4 significant), there is no scale that clearly measures the severity of surgically induced POH.[10,12] The Harner scale[10] mixes the degree affected by POH with the frequency and medication needed to treat it. In the ANA survey, patients rated typical headache severity on a 10-point scale, which is a standard scale for pain measurement. For comparison with previous studies, we defined pain as mild (1–3) moderate (4–7), and severe (8–10). Typical POH was "moderate" intensity in 63% of patients, "severe" in 25%, and "mild" in 12.4%. Similar distributions were noted with regard to sex, size of tumor, and surgical approach. However, only 18% of patients less than 40 years of age reported "severe" typical headaches versus other age groups as follows: 29% (41–55 years), 24% (56–75 years), and 19% (>75 years) ($P = .001$) (Table VIII).

Worst headaches rated "severe" occurred more in women (80%) than men (70.6%) ($P = .03$) and more in younger than in older patients (Table IX). Worst POHs were rated "severe" more often after the retrosigmoid approach versus the translabyrinthine or middle fossa approaches (82.3%, 75.2%, and 63.3%, respectively) ($P < .05$). No relationship was found with regard to tumor size (Table IX).

Headache effect and work disability. Of 1,524 (92%) respondents who rated the degree that they were affected by headaches, 48.8% reported "not at all," 18.4% said "a little," 14.2% "somewhat," 8% "quite a bit," and 10.5% "very much." Thus, most were not significantly affected by POH. Compared with men, women were 60% more likely to be affected "quite a bit" or "very much" (OR = 1.6, $P < .01$). Patients less than 40 years were nearly three times more likely to be affected "quite a bit" or "very much" compared with the least-affected group of patients greater than 75 years (OR = 2.9, $P < .01$). No relationships were found between surgical approach or tumor size and degree affected by POH (Table XII). When compared with translabyrinthine and middle fossa approaches, patients after the retrosigmoid approach were half as likely to report being able to work (Table XI).

Summary of Significant Relationships by Patient Factors

Postoperative headache and surgical approach. Frequencies for being unable to work because of POH were 55.1% after the retrosigmoid approach, 41.8% for the translabyrinthine, and 41.4% for middle fossa approaches ($P = .04$). After the retrosigmoid approach, 82.3% of patients rated worst headaches "severe," which was six

TABLE VI.
Duration of Typical Postoperative Headache Episode.

Duration of Worsened HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	692	222	466	91	288	277	31	372	267	31	158	282	216
<1 hour	22.4	25.7	21	19.8	17	27.4	38.7	22.6	23.2	16.1	24.1	19.9	21.8
1–4 hours	43.1	44.6	42.1	52.7	43.4	39.4	41.9	43.3	41.2	58.1	41.8	45.7	42.1
>4 hours	34.5	29.7	36.9	27.5	39.6	33.2	19.4	34.1	35.6	25.8	34.2	34.4	36.1

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

TABLE VII.
Frequency of Typical Postoperative Headache Episode.

Frequency of Typical HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	683	220	459	88	288	273	29	369	262	30	158	277	211
>1 per day	46	47.7	45.1	45.5	49.3	44	31	45.5	47.7	43.3	48.1	45.5	43.6
>1 per week	33.4	34.5	33.1	39.8	31.9	33.7	31	33.3	33.6	33.3	31	34.7	33.6
<1 per week	20.6	17.7	21.8	14.8	18.8	22.3	37.9	21.1	18.7	23.3	20.9	19.9	22.7

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

times more than after the middle fossa approach (63.3%, $P = .022$). Typical headache intensities were similar among all surgical approaches. Within the first year postoperatively, persistent POH resolved in 48.4% after the translabyrinthine approach versus 23.4% after the middle fossa approach ($P < .05$). However, persistent POH frequencies at 1 year were similar among approaches (70% of translabyrinthine, 60% of retrosigmoid, 61% of middle fossa).

Postoperative headache and age. "Severe" typical headaches occurred in 18% of patients less than 40 years versus 29% for 41 to 55 years, 24% for 56 to 75 years, and 19% for greater than 75 years. Patients aged 41 to 55 years had more "severe" worst POHs compared with patients greater than 75 years (OR = 3.3, $P < .01$). Patients less than 40 years were nearly three times more likely to be affected "quite a bit" or "very much" compared with the least affected group of patients greater than 75 years (OR = 2.9 $P < .01$) (Table XII). Patients 75 or older were least likely to require narcotics and frequently required no treatment for their headaches; however, this only approached statistical significance. (Table X).

Postoperative headache and sex. Compared with men, women experienced preoperative headache 40% more often (37.1% vs. 26%), were 60% more likely to have "severe" worst POHs ($P = .03$), and were 60% more likely to be affected "quite a bit" or "very much" (OR = 1.6, $P < .01$).

Preoperative headache and tumor size. Increased preoperative headache was associated with increasing tumor size, that is, 22.9% small tumors, 31.5% medium tumors, and 41.3% large tumors ($P < .001$) (Table III).

DISCUSSION

During the past several decades, improvements in diagnosis and surgical innovations in the treatment of acoustic neuromas have lowered mortality rates and created less significant morbidity. Once potentially life-threatening, this tumor is now treated electively with high expectations for preservation of the facial nerve, and in select cases, hearing preservation. Persistent POH after acoustic neuroma surgery has been recognized as an increasingly important morbidity. As researchers have attempted to define and determine its causes, the impact on an acoustic neuroma patient's QOL is unknown and difficult to analyze with small study populations. On the basis of the survey results of ANA members, we have identified several patient factors that may help treating physicians counsel prospective surgical patients. Female patients, especially younger ones, were significantly more affected by POH than men. After a retrosigmoid approach, patients had more severe worst headaches that persisted beyond the 3-month perioperative period compared with middle fossa and translabyrinthine approaches. Compared with middle fossa and translabyrinthine approaches, patients after a retrosigmoid approach reported more severe worst headaches that persisted more than 3 months after surgery. However, this dissimilarity diminished 1 year postoperatively. Tumor size was not significantly related to specific measures of POH.

Pathophysiology

In the early 1990s, POH received attention as an emerging significant postoperative morbidity.[3–5,7–11,14] Its precise prevalence is unknown, and few associations or risk factors are established given the rarity of this tumor. Driscoll and Beatty[2] recently reviewed the incidence, mechanism, and treatment for prolonged POH in studies with typically fewer than 150 hundred patients. The retrosigmoid approach, which is favored by neurosurgeons because of its familiarity and effectiveness in the exposure of the posterior fossa, was associated with higher inci-

TABLE VIII.
Intensity of Typical Postoperative Headache Episode.

Intensity of Typical HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	687	217	466	90	285	276	31	371	265	31	157	280	214
1–3	12.4	12.9	12.2	7.8	9.5	14.5	35.5	13.7	10.6	16.1	10.8	12.9	11.7
4–7	62.6	65.4	61.2	74.4	61.8	61.6	45.2	63.9	54.8	60.8	66.2	58.9	65.4
8–10	25	21.7	26.6	17.8	28.8	23.9	19.4	22.4	29	28.7	22.9	28.2	22.9

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

TABLE IX.
Intensity of Worst Postoperative Headache Episode.

Intensity of Worst HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	688	221	463	91	289	274	29	371	265	30	158	280	216
1–3	1.7	0.5	2.4			2.9	13.8	2.7	0.8		1.3	2.5	0.5
4–7	21.1	29	17.5	12.1	14.9	28.8	41.4	22.1	17	36.7	21.5	19.6	19.4
8–10	77.2	70.6	80.1	87.9	85.1	68.2	44.8	75.2	82.3	63.3	77.2	77.9	80.1

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

dences of debilitating persistent POH when compared with the translabyrinthine or middle fossa approaches.[3–5,11] However, it is unclear when in the postoperative courses these comparisons were made and what exact measures of POH were analyzed.

Additional studies endeavored to elucidate the pathophysiology for the observed increased incidence, especially for retrosigmoid or suboccipital approaches.[1,4,5,9–12,14] Several proposed mechanisms include adherence of dural nociceptors to nuchal musculature after suboccipital craniectomies without cranioplasty; inflammatory response of bone dust particles in the arachnoid layer of the posterior fossa; and incisional trauma to the occipital nerves with referred pain.[2,9,12] Variations in the suboccipital incision and even dissection and removal of occipital neuromas have been used to reduce POH.[14] Various techniques for closure of the cranial defect, such as cranioplasty with autologous bone or bone substitutes, have been used with mixed results.[5,9,10,12–14] However, such data were not obtained in our study, and thus the impact of surgical technique in restoring cranium integrity on POH remains speculative. One retrospective study attempted to isolate the presence of bone dust in the posterior fossa as a causative mechanism. In a comparison of similar suboccipital approaches for either acoustic neuroma extirpation or vestibular nerve section in which only the former required intradural drilling, Jackson et al.[1] results showed a significantly higher incidence of POH for acoustic neuroma patients. Silverstein et al.[15] reported a high incidence of POH after vestibular nerve section when the posterior wall of the internal auditory canal was drilled away for better exposure. With the exception of surgical approach and technique, few reports cite any other patient-related factors that could affect POH (e.g., preoperative headache, patient age, sex, tumor size) perhaps because of the small sizes of these studies.

In these ANA respondents, we have identified additional patient factors associated with persistent POH. The ANA provides support and information for patients with acoustic neuromas, promotes research and awareness about this disease, and has more than 5,000 members. Although ANA respondents were treated at large institutions and private practice settings representing wide treatment and practice variability, one may argue that these respondents may not represent a random cross-section of the patient population[6] but rather a group biased based on more negative outcomes. Patients join self-help groups for various reasons that could include those with poor outcomes who feel a need for help and those who are coping well who want to share their positive experiences. The purpose of this study was not to add to the literature yet another case series and to extrapolate our morbidities rates to the entire acoustic neuroma population but to analyze POH in detail among a large group of patients who have experienced POH. This ANA study group may have higher morbidity rates than the average acoustic neuroma series, and may represent one end of the surgical outcome spectrum. Regardless, the perspective of this large group of patients is an invaluable asset for treating physicians counseling patients with acoustic neuromas.

TABLE X.
Treatment Required for Typical Postoperative Headache Episode.

Treatment for Typical Worsened HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	674	217	454	88	276	275	31	362	260	30	153	273	213
No meds	4.7	6.5	4.0	2.3	4.0	5.5	12.9	6.1	3.5	0	3.9	5.1	5.2
NSAIDS	61.3	59.9	61.7	55.7	59.1	62.9	80.6	61.9	58.5	66.7	64.1	57.9	61
Narcotics sometimes	18.5	16.1	19.8	25	18.8	13.8	6.5	16.6	21.2	23.3	13.1	19.8	22.1
Narcotics regularly	15.4	17.5	14.5	17	18.1	13.8	0	15.5	16.9	10	19	17.2	11.7

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache; NSAIDS = nonsteroidal anti-inflammatory drugs.

TABLE XI.
Disability during Typical Postoperative Headache Episode.

Disability during HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	672	217	451	81	262	290	26	361	263	29	153	274	211
Can work	52.8	57.1	51	48.1	54.2	51.7	73.1	58.2	44.9	58.6	57.5	53.6	48.8
Cannot work	47.2	42.9	49	51.9	45.8	48.3	26.9	41.8	55.1	41.4	42.5	46.4	51.2

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.

Impact of Sex and Age on Postoperative Headache

In this study, women and younger patients tended to have poorer outcomes with regard to POH. Compared with men, women experienced more preoperative headaches, more often had POHs beyond 12 weeks, rated their worst headaches as "severe," and were affected by headaches "very much." Pedrosa et al.[4] noted that women reported more "severe" POH than men. Younger patients, particularly ages 40 years and younger, reported POH of longer duration. Patients aged 41 to 55 had an increased odds of having a "severe" worst POH compared with patients greater than 75 years (OR = 3.3, $P < .01$). Patients less than 40 years were nearly three times more likely to be affected "quite a bit" or "very much" compared with patients greater than 75 years (OR = 2.9 $P < .01$) (Table XII). Older patients did not consider POH as significant a morbidity as younger patients did. Patients older than 75 years more often had POH that resolved within 1 year; had fewer and briefer headaches episodes; reported headache intensities for typical and worst episodes that were less severe and more often amenable to NSAIDS or no treatment at all; and felt that POH was less of a disability with regard to work. However, fewer older patients may have been working preoperatively.

Impact of Tumor Size on Postoperative Headache

We found that, similar to Wazen et al.[13] and Jackson et al.,[1] tumor size was not significantly related to qualitative and quantitative measures of POH. However, patients with larger tumors did report more preoperative headaches. In a study by Schaller and Baumann[12] that divided patients into those with and without headache, those with POH tended to have smaller tumors. In an earlier study of the ANA population, we noted that patients with small tumors rated headache a more difficult aspect of the acoustic neuroma experience than those with large tumors.[16] However, facial paralysis and eye problems showed the reverse trend, that is, patients with small tumors who had lower rates of facial nerve problems, rated headache a significant morbidity. Thus, the presence of facial paralysis can be a confounder when analyzing POH because patients with facial nerve problems may not have deemed headache as an important morbidity, and if categorized within a nonheadache group, this may bias one's analysis. We did not compare or analyze patient factors for nonheadache patients in this survey.

Impact of Surgical Approach on Postoperative Headache

On the basis of the findings of this ANA questionnaire, surgical approach affected a number of issues. When the middle fossa approach was performed (typically for smaller tumors), respondents reported headaches were temporary, typically resolved within 12 weeks, and had fewer worst headaches rated "severe." They were also less affected by headache than those after other surgical approaches. These findings concur with other reports of decreased POH with the middle fossa approach.[3,8]

On the basis of anecdotal experience and prior studies,[4,5,11] we expected to find a higher incidence of POH after retrosigmoid approaches compared with translabyrinthine approaches, expecting POH to be more frequent, longer in duration, more intense, associated with a higher

TABLE XII.
Degree Affected by Postoperative Headaches.

Affected by HA	Patients			Ages				Approach			Tumor Size		
	All	Male	Female	<40	41–55	56–75	>75	TL	RS	MF	Small	Med	Large
Answer	1,524	512	1,000	164	517	719	110	880	490	98	303	558	551
Not at all	48.8	54.7	45.5	40.2	41	54.9	54.5	52.3	40.4	62.2	47.5	46.9	51.4
A little	18.4	17.6	19	15.9	20.7	17	22.7	17.2	20.2	18.4	16.2	19.7	17.2
Somewhat	14.2	13.7	14.6	17.7	15.5	13.4	10	13.4	16.9	11.2	14.5	15.1	13.8
Quite a bit	8	7.0	8.6	10.4	8.7	7.1	8.2	8.2	8.2	4.1	9.2	7.9	7.8
Very much	10.5	7.0	12.3	15.9	14.1	7.6	4.5	9	14.3	4.1	12.5	10.6	9.8

TL = translabyrinthine; RS = retrosigmoid suboccipital; MF = middle fossa; HA = headache.
Note: In Table II to XII bolded numbers are merely percentages cited in the body of the text and are not necessarily significant.

incidence of narcotic use, and more often a long-term permanent morbidity. On the basis of our analysis of quantitative and qualitative measures, this was largely not supported, the exception being for retrosigmoid patients, who more often rated worst POHs as "severe" and felt more disabled by inability to work. Our data support a clear difference between the approaches in the immediate postoperative period in terms of resolution. POHs resolved more often within 12 weeks after translabyrinthine approaches (48.4%) than after retrosigmoid approaches (23.4%) but were similar after 1 year. Ruckenstein et al.[11] also found that differences between the two surgical approaches were significant at short term and diminished 1 year after surgery. Most of our retrosigmoid respondents had undergone surgery more than 2 years earlier, which could explain why many specific measures were similar for all approaches, due to recall bias.

CONCLUSIONS

In the largest cohort study to date of acoustic neuroma patients with POH, several patient-related factors were identified. Although these factors could potentially help predict those patients who would be more likely to develop POH, such an extrapolation may not apply to the entire acoustic neuroma population. We found that female patients, especially younger ones, were significantly more affected by POH. Retrosigmoid patients had more severe headaches beyond the 3 month perioperative period and should be aware of the potential for prolonged POH during the first year after surgery. On the basis of the results of the ANA survey, we believe it is incumbent for the treating physicians to familiarize themselves with the sentiments of patients with acoustic neuromas when counseling and recommending optimal management strategies.

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