Postoperative Headache after Undergoing Acoustic Neuroma Surgery via the Retrosigmoid Approach

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Abstract

To estimate the duration of postoperative headache after surgery for acoustic neuroma and the effects of age, sex, tumor size, extent of tumor resection, type of skin incision, surgical duration, hearing preservation, and postoperative facial nerve palsy. This retrospective review analyzed clinical data from 97 patients who had undergone surgery for unilateral acoustic neuroma via the retrosigmoid approach >1 year previously. We investigated whether patients had headache at hospital discharge and during attendance at outpatient clinics. We classified postoperative headache as grade 0 (no headache), 1 (tolerable headache without medication), or 2 (headache requiring medication). The period of headache was defined as the interval in days between surgery and achievement of grade 0. The period of medication for headache was defined as the interval in days between surgery and achievement of grade 0 or 1. Kaplan-Meier analysis revealed median durations of medication and headache of 81 and 641 days, respectively. Headache was cured significantly earlier in patients who underwent surgery using a C-type skin incision (P < 0.001). Headache persisted significantly longer among patients who underwent a shorter surgical procedure (P < 0.02). Multivariate analysis confirmed the type of skin incision as a factor independently associated with duration of postoperative headache. Postoperative headache was cured in the majority of patients within about 2 years after surgery. The C-type skin incision is likely beneficial for reducing the duration of postoperative headache, although headache persisted in a small number of patients.

Key words: acoustic neuroma, postoperative headache, retrosigmoid approach, skin incision

Introduction

Postoperative headache after suboccipital craniotomy is not rare, with a reported incidence of 25–75%.1–5 This complication is common after acoustic neuroma surgery, typically extending from the occiput to the neck as with tension-type headache, but occasionally mimicking migraine.3,6,7 How long postoperative headache continues after surgery remains unclear. If the duration could be clarified, useful information could be provided to patients considering or scheduled to undergo acoustic neuroma surgery. We therefore investigated the duration of postoperative headache for acoustic neuroma in our cases and examined factors potentially affecting the duration.

Materials and Methods

Institutional review board approval was obtained for this study.

Patients

Data were analyzed for patients who underwent resection of unilateral acoustic neuroma using a retrosigmoid approach at Nagoya City University Hospital between July 2006 and March 2014. We excluded patients who: presented with headache on admission; had previously been treated for headache; had received additional surgical treatments for cerebrospinal fluid leakage or wound infection; or had previously undergone surgery for acoustic neuroma.

Duration of headache

We investigated whether patients had headache at hospital discharge and during attendance at
outpatient clinics. Patients completed the following brief questionnaire both at hospital discharge and on follow-up at outpatient clinics: Question 1) Have you been experiencing headache or wound pain since the surgery (regardless of severity)?; and Question 2) Do you need medication for headache or wound pain (regardless of frequency)? Patients answered either “Yes” or “No” to each question. Patients repeatedly received this questionnaire on the day of consultation. We then classified postoperative headaches as grade 0 (no headache), 1 (tolerable headache without medication), or 2 (headache requiring medication). The period of medication for headache was defined as the number of elapsed days between the date of surgery and the date on which the patient first achieved grade 0 or 1 (i.e., no longer required medication for headache). The period of headache was defined as the number of days between the date of surgery and the date on which the patient first achieved grade 0 (i.e., no longer experienced headache). If the patient received stereotactic radiosurgery after tumor resection, the last observation day was defined as the day of consultation on which stereotactic radiosurgery was recommended.

Outpatient clinic

Usually patients visited the outpatient clinic in our hospital about 3 weeks after discharge, then again at 3 months, 6 months, and 1 year after surgery. Thereafter, the patient visited once or twice a year, according to their individual condition. If a patient was followed-up at another institution, the last observation day was defined as the day on which the patient last visited our hospital.

Surgical procedure for retrosigmoid approach

The head was secured in a 3-point fixation in a Mayfield headholder. The patient was placed in the park-bench position. Degree of neck flexion was not modified according to tumor size.

Procedures for skin incision with muscle dissection were classified into 2 patterns: lazy S or C-type.

The lazy S incision was started 4 cm above the superior nuchal line, passing through the point halfway between the inion and mastoid process, and descending along the midline of the cervical spine (Fig. 1A). The sternocleidomastoid, semispinalis capitis, and splenius capitis muscles were divided along the skin incision and retracted bilaterally. The rectus capitis posterior major and inferior oblique muscles were detached from the skull bone and retracted caudally.

The C-type incision was a semicircular skin incision starting 2 cm above the superior nuchal line, passing through a point about 2 cm inside the asterion, and descending 2 cm behind the mastoid process (inside the hairline of the neck) (Fig. 1B). The sternocleidomastoid muscle was reflected laterally,

Fig. 1 The 2 types of skin incision used in this study. (A) lazy S skin incision, (B) C-type skin incision. Retraction and stretching of the GON are likely to occur in lazy-S skin incision. GON: greater occipital nerve; LON: lesser occipital nerve.
Postoperative Headache after Acoustic Neuroma Surgery

while the other suboccipital muscles (semispinalis capitis, splenius capitis, rectus capitis posterior major, and inferior oblique muscles) were detached and folded back.

With both of these incisions, two burr holes were then made and an osteoplastic craniotomy approximately 4 cm wide was created.

We generally aimed for total removal of the tumor, but some parts of the tumor were intentionally left to preserve neurological function, depending on the intraoperative condition.

After closure of the dura, the bone flap was replaced and secured with titanium plates and screws. The muscles and skin incisions were then rejoined and sutured together. No drainage tube was placed.

Factor analysis for postoperative headache
We examined whether the duration of headache could be affected by age, sex, tumor size, type of skin incision, extent of tumor resection, surgical duration, hearing preservation, or postoperative facial nerve palsy.

Age
Patient age at surgery was classified into 3 groups. Patients <40 years old were classified as young, those between 40 and 64 years old as middle-aged, and those ≥65 years old as aged.

Tumor size
Maximal extrameatal diameter of the tumor was estimated on T1-weighted axial contrast-enhanced magnetic resonance imaging. Tumor size was classified into 3 groups. Tumors ≤15 mm were classified as small, those 16–30 mm as medium, and those >30 mm as large.

Type of skin incision
The lazy S and C-type skin incisions described above were applied in this series.

Extent of tumor resection
Extent of tumor resection was estimated from intraoperative microscopic findings and postoperative magnetic resonance imaging (MRI). Three groups were classified. Total or near-total resection was defined as total tumor clearance or only tumor capsule remaining. Cases in which a small tumor remnant was left on the facial nerve, other cranial nerves or brainstem were considered to represent subtotal resection. Partial resection was defined as >5% of the tumor left behind.

Surgical duration
Mean surgical time for all patients was calculated according to the surgical records at our hospital. Surgical duration was classified into 2 groups: less than or equal to the mean surgical time was classified as short and over the mean surgical time as long.

Hearing preservation
Pure-tone average and speech discrimination scores were determined 1–7 days before surgery and approximately 2 weeks after surgery. Pre- and postoperative hearing results were classified according to the Gardner-Robertson criteria.8 A preoperative result of Class 5 was classified as preoperative deafness. A postoperative result of Class 4 or better was classified as preserved. A preoperative result of Class 4 or better and postoperative result of Class 5 was classified as not preserved.

Postoperative facial nerve palsy
Facial nerve outcomes were estimated according to the House-Brackmann system9 at the time of hospital discharge. Grade III and over was classified as postoperative facial nerve palsy.

Statistical analyses
Statistical analysis was performed using R-2.14.0 software (R Foundation, Vienna, Austria). Kaplan-Meier curves were used to estimate the durations of medication and postoperative headache. Analyses of differences were performed using the log-rank test. Multivariate analysis was performed to identify independent predictors for the duration of postoperative headache with Cox proportional hazards model. Statistical significance was set at the level of P < 0.05.

Results
Ninety-seven patients (57 women, 40 men) were investigated in this study. Six patients received stereotactic radiosurgery after tumor removal during the observation period. Mean age at surgery was 51.7 years (range, 23–81 years).

According to the Kaplan-Meier curves, median duration of medication for headache was 81 days and median duration of headache was 641 days (Fig. 2).

[Age] Nineteen patients were classified as young, 62 patients as middle-aged, and 16 patients as aged.

[Tumor size] Twenty-one patients were classified as showing small tumors, 65 as showing medium tumors, and 11 as showing large tumors. [Type of skin incision] Sixty-seven patients underwent surgery using a lazy S incision and 30 using a C-type incision. [Extent of tumor resection] Total or near-total resection was achieved in 48 patients, subtotal resection in 35 patients, and partial resection
Fig. 2 Kaplan–Meier curve estimating the duration of medication for headache (solid line) and the duration of headache (dashed line).

Fig. 3 Kaplan–Meier curve for estimating the duration of headache according to the type of skin incision. Solid line: C-type; dashed line: lazy S. Log-rank testing revealed that headache ended significantly earlier in patients who underwent surgery involving a C-type skin incision (P < 0.001).

Fig. 4 Kaplan–Meier curve for estimating the duration of headache according to surgical duration. Solid line: short surgery; dashed line: long surgery. Log-rank testing revealed that postoperative headache persisted significantly longer among patients who underwent a short surgical procedure (P < 0.02).

Discussion
Postoperative headache after suboccipital craniotomy is a problem with surgery for acoustic neuroma. A previous report found that 32% of patients complained of persisting headache syndrome with a severity of at least 6/10 on the nominal analogue scale at 6 months after surgery.10 The occurrence of postoperative headache and the failure of patients to return to preoperative levels of activity were associated with each other, and correlated significantly with the risk displayed postoperative facial nerve palsy. [Hearing preservation] Forty-two patients were classified as showing preserved hearing, 44 patients as showing not preserved hearing, and 11 patients as showing preoperative deafness.

Log-rank testing revealed that headache ended significantly earlier in patients who underwent surgery involving a C-type skin incision (P < 0.001) (Fig. 3). Postoperative headache persisted significantly longer among patients who underwent a short surgical procedure (P < 0.02) (Fig. 4). No significant differences in duration of headache were seen for sex, age, tumor size, extent of tumor resection, hearing preservation, or postoperative facial nerve palsy. Multivariate analysis confirmed type of skin incision as a factor independently associated with duration of postoperative headache (Table 1).
of postoperative retirement, indicating an important socioeconomic impact of headache in these patients.\(^\text{10}\) Surgeons should thus be well acquainted with issues around the duration of postoperative headache. Kaplan-Meier analysis in the present study revealed median durations of medication and headache of 81 and 641 days, respectively. The postoperative headache in this study was distributed at the occiput (98%), forehead, (3%) temple (2%) and eye (2%) (\(n = 64\)). Fifty-five of 64 patients (91%) complained of symptoms (pressing or tightening quality) similar to tension-type headache and it has been previously reported that this type of headache is prevalent.\(^\text{3,6,7}\) Headaches such as occipital neuralgia (shooting, stabbing or sharp quality) were also common (19 of 64 cases: 30%), as previously reported.\(^\text{10,11}\)

Two patients complained of unilateral pulsating pain like migraine. During the follow-up period, we classified postoperative headache into only 3 grades, so the severity of headache was differed among individual patients. Types of headache might have changed. Therefore, we cannot determine which type of headache continued for a long period in this study. Patients with grade 2 headache are commonly treated using nonsteroidal anti-inflammatory drugs, and some require anxiolytic drugs. It has been previously reported that local anesthetic blockade of the occipital sensory nerves is effective.\(^\text{11}\) We also could reduce headache with local anesthetic blockade in 3 cases. Given the median duration of medication of 81 days, the majority of patients did not require any medication within 3 months. The present study defined the period of headache as the number of days between surgery and first achieving a state of no headache at discharge or at the outpatient clinic. The possibility thus remains that postoperative headache may have already been cured before visiting our hospital. This means that the actual duration of headache was probably shorter than the estimated duration of headache in this study. Postoperative headache would thus have been cured in the majority of patients within 2 years. The information derived from this study should prove of value to both surgeons and patients undergoing surgery. The possibility that headache grade will deteriorate after classification as grade 0 or 1 must be considered. In fact, no cases in this series showed deterioration.

We applied 2 types of skin incision in this series. Selection of skin incision did not depend on preventing postoperative headache. We preferred to use the lazy \(S\) incision at the beginning of this series. Because the divided skin and muscles occasionally built something like a bank that deepened the operative field, we have more recently preferred to make skin flaps. The \(C\)-type skin incision has thus recently been applied. A key limitation of this study was thus that the type of skin incision was not randomly selected. Surgical duration of the \(C\)-type skin incision was longer than the lazy \(S\) skin incision (Table 2). The reason for

<table>
<thead>
<tr>
<th>Variable</th>
<th>RR</th>
<th>95% CI</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.10</td>
<td>0.74–1.65</td>
<td>0.63</td>
</tr>
<tr>
<td>Sex</td>
<td>1.23</td>
<td>0.76–1.98</td>
<td>0.39</td>
</tr>
<tr>
<td>Tumor size</td>
<td>1.07</td>
<td>0.66–1.73</td>
<td>0.77</td>
</tr>
<tr>
<td>Type of skin incision</td>
<td>0.52</td>
<td>0.29–0.95</td>
<td>0.03*</td>
</tr>
<tr>
<td>Extent of tumor resection</td>
<td>1.28</td>
<td>0.93–1.77</td>
<td>0.13</td>
</tr>
<tr>
<td>Surgical duration</td>
<td>1.31</td>
<td>0.73–2.34</td>
<td>0.37</td>
</tr>
<tr>
<td>Hearing preservation</td>
<td>1.27</td>
<td>0.86–1.88</td>
<td>0.24</td>
</tr>
<tr>
<td>Postoperative facial nerve palsy</td>
<td>0.85</td>
<td>0.39–1.83</td>
<td>0.68</td>
</tr>
</tbody>
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CI: confidence interval, RR: relative risk, *\(P\)-value < 0.05 considered statistically significant.

Table 2 Comparison of characteristics between lazy \(S\) and \(C\)-type skin incisions

<table>
<thead>
<tr>
<th></th>
<th>Lazy (S) ((n = 67))</th>
<th>(C)-type ((n = 30))</th>
</tr>
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<tbody>
<tr>
<td>Mean age (years)</td>
<td>52.8</td>
<td>49.1</td>
</tr>
<tr>
<td>Sex, (n) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>38 (57)</td>
<td>19 (63)</td>
</tr>
<tr>
<td>Male</td>
<td>29 (43)</td>
<td>11 (37)</td>
</tr>
<tr>
<td>Tumor size, (n) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>19 (28)</td>
<td>2 (7)</td>
</tr>
<tr>
<td>Medium</td>
<td>45 (67)</td>
<td>20 (67)</td>
</tr>
<tr>
<td>Large</td>
<td>3 (4)</td>
<td>8 (27)</td>
</tr>
<tr>
<td>Extent of tumor resection, (n) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total or near-total</td>
<td>39 (58)</td>
<td>9 (30)</td>
</tr>
<tr>
<td>Subtotal</td>
<td>19 (28)</td>
<td>16 (53)</td>
</tr>
<tr>
<td>Partial</td>
<td>9 (13)</td>
<td>5 (17)</td>
</tr>
<tr>
<td>Surgical duration, (n) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td>50 (75)</td>
<td>11 (37)</td>
</tr>
<tr>
<td>Long</td>
<td>17 (25)</td>
<td>19 (63)</td>
</tr>
<tr>
<td>Mean (min)</td>
<td>457</td>
<td>551</td>
</tr>
<tr>
<td>Hearing preservation, (n) (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preserved</td>
<td>32 (48)</td>
<td>10 (33)</td>
</tr>
<tr>
<td>Not preserved</td>
<td>29 (43)</td>
<td>15 (50)</td>
</tr>
<tr>
<td>Preoperative deaf</td>
<td>6 (9)</td>
<td>5 (17)</td>
</tr>
<tr>
<td>Postoperative facial nerve palsy, (n) (%)</td>
<td></td>
<td>7 (10)</td>
</tr>
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</table>
this must be that many patients having a large tumor underwent using a C-type skin incision and that the surgical procedure of the C-type skin incision is more complicated than lazy S skin incision. The lesser occipital nerve (LON) was transected among these two incisions. On the other hand, handling of the greater occipital nerve (GON) varied, although some variations are seen in the intramuscular course of the GON.\textsuperscript{12} The GON was rarely transected and usually preserved during division of the splenius capitis muscle with the lazy S skin incision. However, the GON was retracted and stretched by the self-retaining retractors regardless of preservation. With a C-type skin incision, the GON was neither transected nor stretched. Preservation of the GON has previously been reported as independently associated with postoperative headache.\textsuperscript{13} In that report, the lazy S skin incision had been applied and the GON had been transected in 66 of 280 patients during the surgery. The incidence of postoperative headache in the GON transected group was significantly lower than the GON preserved group. The authors suggested that retraction and stretching of the GON for preservation might have led to nerve injury and postoperative pain. Other reports have revealed that postoperative headache appeared directly related to the presence of occipital nerve injury.\textsuperscript{14} Considering the fold and stretch of the GON, the C-type skin incision barely injures the GON. This seems a likely reason why postoperative headache resolved significantly earlier in patients who underwent surgery involving a C-type skin incision. Postoperative muscle atrophy has been previously reported to be significantly reduced with the C-type skin incision compared with the lazy S skin incision.\textsuperscript{15} Although the dissection of muscles in that report differed somewhat compared to our procedure, this may mean that occipital nerve entrapment in the injured muscles is unlikely with the C-type skin incision. However, further studies, for example a randomized controlled trial, are needed to find the reason why the C-type skin incision is beneficial for reducing the duration of postoperative headache, because the characteristics between lazy S and C-type skin incisions in our study were very different (Table 2). Other etiologies in addition to injury of the GON have been suggested to involve dural adhesions\textsuperscript{8,16} and aseptic meningitis.\textsuperscript{17} We replaced the bone flap to prevent dural adhesion in all cases in the present study. We irrigated the operative field with artificial cerebrospinal fluid to prevent aseptic meningitis in all cases, regardless of the type of skin incision. Of course, the handling of the GON differs markedly if the muscles are dissected layer by layer through a lazy S incision. In that case, the duration of postoperative headache may differ from our results. Headache persisted longer among patients who underwent a shorter surgical procedure. Surgical duration was not a factor independently associated with duration of postoperative headache. It may be because the group of lazy S skin incision included many patients undergoing short surgery (Table 2). In general, the longer the duration of surgery, the greater the degree of physiological stress. The result in this study means that physiological stress from surgery is clearly not the sole determinant of postoperative headache. Stress and mental tension have been reported as the most common factors causing tension-type headache.\textsuperscript{18} We suggest that patient who undergo long surgeries can easily appreciate the severity of surgery. On the other hand, some patients who undergo short surgeries may underrate the severity of surgery. Tumor size was not a factor associated with the duration of postoperative headache in our study. Small tumor size has been reported to predict postoperative problems with headache.\textsuperscript{19} Patients who had a smaller tumor may have underrated the surgery. Discordance between the perceived acceptability of the surgery and subsequent experience would presumably contribute to stress and mental tension, which in turn would contribute to postoperative headache. A clear comprehension of the scheduled surgery may thus be an important factor in postoperative headache, although the mechanisms remain unclear.

The occurrence of postoperative headache correlated significantly with preoperative headache and the number of perioperative complications.\textsuperscript{10,19} We excluded patients having preoperative headache. Some of the preoperative headaches are probably unrelated to the tumor. The purpose of this study is to estimate duration of postoperative headache, or surgery-related headache. If we confuse non surgery-related headache for postoperative headache, we cannot correctly analyze the duration of postoperative headache. Low intracranial pressure condition by postoperative cerebrospinal fluid leakage may affect postoperative headache. Our study excluded patients who had received additional surgical treatments for cerebrospinal fluid leakage or wound infection. There was no case with cerebrospinal fluid retention under the skin at hospital discharge. Therefore, we suspect that low intracranial pressure condition by cerebrospinal fluid leakage did not affect postoperative headache for a long time. Postoperative facial nerve palsy and hearing preservation were not independently associated with duration of postoperative headache. We cannot say for certain whether preoperative headache and the number of perioperative complications can help predict the duration of postoperative headache. There was no case treated for cervical spondylosis in this study. Before the surgery, we checked whether all patients have any symptom
under the same degree neck flexion as during surgery. There was no case having any symptom. However, further studies are needed to estimate other possible factors including cervical spine alignment, tinnitus, postoperative muscle atrophy and so on. In any case, multiple factors are probably involved in postoperative headache. Our study revealed that the C-type skin incision is likely beneficial for reducing the duration of postoperative headache.

**Conclusion**

Postoperative headache after suboccipital craniotomy is a problem for acoustic neuroma surgery. Kaplan-Meier analysis in this study revealed median durations of medication and headache as 81 and 641 days, respectively. Headache resolved significantly earlier in patients who underwent surgery using a C-type skin incision. Multivariate analysis confirmed type of skin incision as a factor independently associated with duration of postoperative headache. Thus, the C-type skin incision seems beneficial for reducing the duration of postoperative headache although headache persisted in a small number of patients.

**Conflicts of Interest Disclosure**

All authors have no conflicts of interest with regard to the manuscript submitted. All authors who are members of the Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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