Epidemiology of post-suboccipital craniotomy headaches: A multicentre retrospective study

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Abstract

The detailed epidemiology and mechanism of post-craniotomy headaches are not well understood. This study aimed to establish the actual clinical incidence and causes of post-craniotomy headaches. Suboccipital craniotomy surgeries performed in six institutions within the 5-year study period were included. This study included 311 patients (138 males, 173 female; mean age, 59.3 years old). A total of 145 patients (49%) experienced post-craniotomy headaches. Microvascular decompression surgery, craniectomy, and facial spasms were significant risk factors for post-craniotomy headaches. In most cases, the post-craniotomy headaches disappeared within 1 month; however, some patients suffered from long-term headaches. The craniotomy site and the methods of dura and skull closures should be individually determined for each patient. However, to prevent post-craniotomy headaches, craniotomy, instead of craniectomy, may be considered.

Keywords: Microvascular Decompression, Craniotomy, Facial Spasm, Post-craniotomy headache, suboccipital craniotomy

Introduction

Post-craniotomy headache is an established disease entity that is defined in the International Classification of Headache Disorders (Headache classification committee, 2018). Acute headache attributed to craniotomy (5.5) is defined as headache of less than 3 months' duration caused by surgical craniotomy. Persistent headache attributed to craniotomy (5.6) is defined as headache of more than 3 months' duration caused by surgical craniotomy. According to the description of the International Classification of Headache Disorders, about a quarter of patients who develop acute headache attributed to craniotomy go on to experience persistent headache attributed to craniotomy. The current diagnostic criteria define post-craniotomy headache as a secondary headache that develops within 7 days following craniotomy (Headache classification committee, 2018). This definition of onset is arbitrary and does not come from reasonable evidence. We sometimes observe patients develop post-craniotomy headache within 7 days following craniotomy. So a revision of these diagnostic criteria, in which the onset of headache is extended to 7–30 days following craniotomy, has been proposed (Rocha-Filho et al., 2010). Post-craniotomy headache is a complication that the neurosurgeon would like to avoid in order for surgery to be successful. Studies on post-craniotomy headaches are scarce, thus, their detailed epidemiology and mechanism are not well understood.

Post-craniotomy headaches are frequently reported following suboccipital craniotomy surgery (Vijayan, 1995, Pedrosa et al., 1994, Shibata, 2020). Some studies have reported that dural tension and adhesion between the dura and subcutaneous tissue may be the causes of post-craniotomy headaches (Schaller and Baumann, 2003, Koperer et al., 1999, Kaur et al., 2000, Porter et al., 2009, Gee et al., 2003). Most of these studies analysed small

case series; thus, the actual incidence, risk factors, clinical course, and prognosis are not clear. The risk factors of post-craniotomy headache reported in previous studies include muscle dissection, neural damage, patient position, and anaesthetics (Lutman et al., 2018, Subbarao et al., 2021) .

We conducted a retrospective multicentre cooperative study to investigate the epidemiology, risk factors, clinical course, and prognosis of post-suboccipital craniotomy headaches. This study aimed to establish the actual clinical incidence and causes of post-suboccipital craniotomy headaches and to contribute to their diagnosis and prevention.

Materials and methods

Study population

This study included patients aged between 6 and 90 years who underwent suboccipital craniotomy surgery at participating institutions within the 5 years from January 2015 to December 2019. Patients with pre-surgical chronic headaches and surgical complications were excluded from the study, as well as those who could not complain of headaches due to consciousness disturbance or impaired verbal function. A surgical complication was routinely investigated using appropriate examinations including imaging. All patients were followed up for more than 6 months. Those who demonstrated rapid progression of primary diseases during the 6 months following surgery were also excluded. No patient in our study population received opioids, neuromodulating medications, or neuromodulating physical therapy.

Methods

This was a multicentre cooperative retrospective study. The study protocol was approved by the review board of each institution (reference number 19-35). Furthermore, the study protocol was registered at the University Hospital Medical Information Network (UMIN) Centre and posted on the websites of UMIN (ID 000038930) and of each participating institution. Opt-out options were indicated; hence, patient consent was not obtained (Vellinga et al., 2011).

All suboccipital craniotomy surgeries performed at four institutions in the 5-year study period were included. At two large-volume institutions, suboccipital craniotomy surgery performed by the participating neurosurgeons over the previous 3 years was included. The investigators collected the following data at their respective institutions: age at surgery, sex, primary disease, laterality, comorbid disease, surgical procedure, skin incision, craniectomy or craniotomy, and method of dural closure. The presence and timing of the appearance and disappearance of post-craniotomy headaches were investigated based on medical chart reviews. In this study, a post-craniotomy headache was defined as a pathological headache occurring after craniotomy surgery. Facial pain that was existed before craniotomy surgery was not included as a headache in this study.

The collected data were centrally analysed. Statistical analyses were conducted *via t*-test, Fisher's exact test, and logistic regression analysis using the SPSS software (ver. 24.00, IBM, Tokyo, Japan) and a free software, namely, R (ver. 4.0.3, R Foundation, Vienna, Austria). A p-value < 0.05 was considered significant. The Strengthening the Reporting of Observational Studies in Epidemiology Statement guidelines were implemented in the design and conduct of this study.

Results

A total of 311 patients (138 males, 173 female; mean age, 59.3 years old) were registered. The surgical procedures included microvascular decompression (MVD) (n = 193; male, n = 81; female, n = 112; mean age, 60.3 years), tumour removal (n = 86; male, n = 36; female, n = 50; mean age, 56.8 years), cerebrovascular disease (CVD) (n = 29; male, n = 20; female, n = 9; mean age, 64.2 years), Chiari malformation (n = 2), and epidural haematoma (n = 1) (Table 1). Our study population included only 1 pediatric patient who was diagnosed with traumatic epidural haematoma. Thus, the MVD, tumour, and CVD groups did not include pediatric patients.

A total of 145 patients experienced post-craniotomy headaches (49%; male, n = 53; female, n = 92; mean age, 59.0 years). Of these patients, 128 underwent MVD (128/193MVD cases, 66%), 36 had trigeminal neuralgia (36/67 trigeminal neuralgia cases, 54%), 90 had facial spasms (90/123 facial spasm cases, 73%) and 2 had hypoglossal neuralgia (2/2 hypoglossal neuralgia cases, 100%). Age and laterality were not risk factors for post-craniotomy headaches. In all MVD surgeries, the patients' fasciae were used for dural closure. Univariate analysis revealed that craniectomy ($p < 0.001$), facial spasms ($p = 0.007$), and female sex ($p = 0.045$) were significant risk factors for post-craniotomy headache (Table 2). In the multivariate analysis, craniectomy (odds ratio = 7.043, 95% confidence interval [CI] 2.6–12.33; $p < 0.001$) and facial spasm (odds ratio = 0.381, 95% CI 0.23–0.79; $p = 0.007$) were identified as significant independent risk factors for post-craniotomy headaches.

Post-craniotomy headaches were observed in 15 patients (17%) who underwent tumour surgery (Table 1). The pathological diagnoses of our tumour cohort were 25 acoustic tumours, 20 meningiomas, 9 hemangioblastomas, 2 gliomas, 22 metastases, and 8 other tumours. Among 25 patients with acoustic tumours, 5 (20%) experienced post-

craniotomy headaches. Univariate analysis revealed that benign tumours were a significant risk factor for post-craniotomy headaches ($p = 0.044$). However, multivariate analysis found no significant factors.

The CVD group included 14 haematoma removals, 10 aneurysm clippings, 3 decompressive craniotomies, and 2 arteriovenous malformation removals. Among patients with CVD, post-craniotomy headaches were observed only in two female patients who underwent aneurysm clipping (7%) (Table 1).

In most cases (n = 138; 97.0%), post-craniotomy headache started within 7 days following surgery (Figure 1) and disappeared within 30 days following surgery. However, in 10 patients (7%), post-craniotomy headache persisted more than 91 days following surgery. Furthermore, in five patients whose headaches started more than 8 days after surgery, the headaches became chronically persistent for more than 130 days. Most patients with persistent post-craniotomy headache were treated with oral analgesia.

Discussion

Frequency of post-craniotomy headaches

In our study, almost half of the patients who underwent suboccipital craniotomy experienced post-craniotomy headache. Most reported literatures of post-craniotomy headaches are the acoustic neuroma surgery. Two previous reports (Vijayan, 1995, Rimaaja et al 2007) on post-craniotomy headaches following acoustic neuroma surgery obtained incidence rates of 42% and 64%. In our cohort, the incidence of post-craniotomy headaches following acoustic neuroma surgery was 20%.

Lee et al (2017) introduced endoscopic MVD surgery for trigeminal neuralgia, which reduced the incidence

of headaches at 1 month after endoscopic MVD to 7% lower than that after microscopic MVD surgery (21%). Lee et al. posit that a smaller craniotomy flap may reduce the risk of postoperative headaches. However, after 3 years, both the endoscopic and microscopic MVD groups yielded equivalent results for pain control reported by 80% of the patients. Silverman et al (2004) reported technical modifications of suboccipital craniectomy, including a skin incision designed to avoid the lesser and greater occipital nerves, a small craniectomy, no intradural drilling of bone, and a simplified closure to prevent muscle adhesion to dura. The cases involved 53 consecutive retrosigmoid vestibular nerve sections for intractable peripheral vestibular disorders or MVD. The total incidence of post-craniotomy headache was 7.5% at 3 months and 3.8% at 2 years postoperative, whereas for 41 MVD patients, the incidences were 7.3% and 4.9%, respectively. In our MVD patients, the incidence of post-craniotomy headaches was 66%. The reason for this relatively high incidence may be the inclusion of significant proportions of patients who had facial spasms, and underwent craniectomy in our study population.

In patients who underwent supratentorial craniotomy surgery, the incidence rates of post-craniotomy headaches (Rocha-Filho et al., 2008) and persistent headaches (Kaur et al., 2000) at 1 year after surgery were 40% and 11.9%, respectively. Thus, although the incidence of post-craniotomy headaches following supratentorial surgery may be smaller than that following suboccipital craniotomy, a significant number of patients still suffer from post-craniotomy headaches.

Risk factors for post-craniotomy headaches

Our multivariate analysis of the patients who underwent MVD surgery revealed that craniectomy and facial spasms were significant risk factors for post-craniotomy headaches. In general, surgery for facial spasms required a

larger and more caudal craniotomy than that for trigeminal neuralgia (Cohen-Gadol, 2011). These results are in line with those of the literature (Koperer et al., 1999, Kaur et al., 2000, Porter et al., 2009). One study (Harner et al., 1995) reported that the incidence of post-craniotomy headaches was lower in patients who underwent retrosigmoid cranioplasty (4%) compared with historically matched patients who underwent retrosigmoid craniectomy (17%). Among those who underwent MVD surgery, female patients exhibited a relatively high incidence of post-craniotomy headaches. Female sex was identified as a significant factor in the univariate analysis but not in the multivariate analysis (Table 3). The literature reports a high rate of post-craniotomy headaches in women and younger patients (De Beneditis et al 1996, Molnar et al 2014).

In patients who underwent tumour surgery, a benign tumour and young age tended to be associated with a high incidence of post-craniotomy headaches. However, these factors were not found to be significant in the multivariate analysis. Benign tumour surgery was frequently performed on younger patients. Thus, benign tumours and young age were confounding factors. Craniectomy was not a significant risk factor for post-craniotomy headaches following tumour surgery, which may be due to the small number of brain tumour patients who underwent craniectomy in our study. The patients who underwent dural closure with an artificial dura exhibited a lower incidence of post-craniotomy headaches. However, this was not statistically significant. More than half of the patients with brain tumours underwent direct dural closures. Furthermore, patients with malignant or residual benign tumours had a risk of intracranial hypertension. Thus, craniectomy and artificial dural closure were intentionally selected for these patients. The craniotomy site and closure methods of the dura and skull should be individually determined for each patient. However, to prevent post-craniotomy headaches, craniotomy, instead of craniectomy, may be

considered.

Time course of post-craniotomy headaches

Most post-craniotomy headaches started within 7 days following surgery and disappeared within 30 days. The International Classification of Headache Disorders (2018) define acute post-craniotomy headache as a headache that starts within 7 days following craniotomy surgery and disappears within 3 months. Thus, most of our patients suffered acute post-craniotomy headaches. However, in some cases, post-craniotomy headaches observed more than 91 days following surgery. Headaches that start more than 8 days after surgery are defined as persistent chronic headaches. Some studies reported similar results (Rocho-Filho et at 2008, Rocho-Filho et al 2010). The current diagnostic criteria define a post-craniotomy headache as a secondary headache developing within 7 days after craniotomy. A revision of these diagnostic criteria, in which the onset of headache is extended to 7–30 days after craniotomy, has been proposed (Rocha-Filho et al., 2010). These data suggest that a secondary pathology, such as adhesion between the dura and subcutaneous tissue, may be the cause of delayed chronic post-craniotomy headache.

Strengths of the study

Our study has some strengths. Most previous studies on post-craniotomy headaches were single-centre or single-surgeon studies that only analysed limited number of surgeries, such as acoustic tumour and MVD (Lee et al., 2017),. Our study is a multi-institution study and included various suboccipital craniotomy procedures. Our study investigated various factors that may lead to post-craniotomy headaches *via* univariate and multivariate analyses. While one study only included cases with surgical complications (Lee et al., 2017), our study excluded these complicated cases from the analysis to examine the direct effect of the surgery itself.

Limitations of the study

The present study has some limitations. Due to the retrospective design of our study, headaches were judged based on the descriptions in medical records. Some patients did not provide a detailed description of their headaches. Thus, the severity of headaches was not evaluated. However, patients who used analgesics after craniotomy surgery were included among those with post-craniotomy headaches. We, therefore, believe that the incidence rate of post-craniotomy headaches may be accurate.

Patients with preoperative chronic headaches or surgical complications were excluded. The diagnoses of preoperative chronic headaches and surgical complications depended on each neurosurgeon at each institution. Chronic headaches and postsurgical complications, including intracranial hemorrhage, infectious and aseptic meningitis, and other conditions, were diagnosed in routine clinical practice. We can therefore confirm that the cases of post-craniotomy headache evaluated in this study were not caused by preoperative headaches or surgical complications. Postsurgical follow-up data were obtained from the patients' medical charts. Usually, the condition of the admitted patient is recorded every day in a medical chart. However, for patients followed up on an outpatient basis, data were only recorded on the days that the patient visited.

Although our study was a multicentre cooperative study, we included all suboccipital craniotomy operations performed in the past 5 years in four institutions and all suboccipital craniotomy operations performed in the past 3 years in two high-volume institutions. Thus, the patient population of each institution was highly variable. By centrally analyzing all the data, we may have obtained comprehensive results. The details of the surgical procedures, including scalp incision, muscle dissection, intra- and extradural skull drilling, closure techniques, occipital nerve

injury, and the use of fibrin glue, may differ among each surgeon, and these factors may be related to post-craniotomy headaches (Aihara et al., 2017, Chowdhury et al., 2017). Anaesthetic agents used during and after surgery may also be associated with post-craniotomy headaches (Chowdhury et al., 2017). However, our neurosurgical practice in this study was within the current Japanese health insurance coverage; thus, standardisation was achieved to the maximum possible extent. We usually use preoperative local surgical site infiltration of xylocaine and intravenous fentanyl to control surgical pain during and immediately after craniotomy.

Psychiatric conditions, such as depression and anxiety, have also been reported to be related to headaches (Rocha-Filho et al., 2010, Rimaaja et al., 2007, Chowdhury et al., 2017). Detailed surgical procedures, anaesthetic agents, or psychiatric conditions would be difficult to analyze in a retrospective study. Thus, they were not evaluated in this study. However, we are planning to conduct further prospective studies that address these additional factors.

Conclusion

Post-craniotomy headaches were frequently observed following suboccipital craniotomy surgery. MVD, facial spasms, and craniectomy were significantly associated with post-craniotomy headaches. In most cases, post-craniotomy headache disappeared within 1 month; however, some patients suffered chronic headaches. The methods for craniotomy and dura and skull closures should be individually determined for each patient. However, to prevent post-craniotomy headaches, craniotomy, instead of craniectomy, may be considered.

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