Delayed postoperative hemorrhage in 21 patients with intracranial epidermoid cysts

Clinical article

XIAO-HUI REN, M.D.,1,2 CHUN CHU, M.D.,2 CHUN ZENG, M.D.,2 YONG-JI TIAN, M.D.,2 ZHEN-YU MA, M.D.,2 KAI TANG, M.D.,2 LAN-BING YU, M.D.,2 XIANG-LI CUI, M.D.,2 ZHONG-CHENG WANG, M.D.,1,2 AND SONG LIN, M.D.2

1Beijing Neurosurgical Institute, Capital Medical University; and 2Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Beijing, China

Object. Intracranial epidermoid cysts are rare, potentially curable, benign lesions that are sometimes associated with severe postoperative complications, including hemorrhage. Delayed hemorrhage, defined as one that occurred after an initial unremarkable postoperative CT scan, contributed to most cases of postoperative hemorrhage in patients with epidermoid cyst. In this study, the authors focus on delayed hemorrhage as one of the severe postoperative complications in epidermoid cyst, report its incidence and its clinical features, and analyze related clinical parameters.

Methods. There were 428 cases of intracranial epidermoid cysts that were surgically treated between 2002 and 2008 in Beijing Tiantan Hospital, and these were retrospectively reviewed. Among them, the cases with delayed postoperative hemorrhage were chosen for analysis. Clinical parameters were recorded, including the patient’s age and sex, the chief surgeon’s experience in neurosurgery, the year in which the operation was performed, tumor size, adhesion to neurovascular structures, and degree of resection. These parameters were compared in patients with and without delayed postoperative hemorrhage to identify risk factors associated with this entity.

Results. The incidences of postoperative hemorrhage and delayed postoperative hemorrhage in patients with epidermoid cyst were 5.61% (24 of 428) and 4.91% (21 of 428), respectively, both of which were significantly higher than that of postoperative hemorrhage in all concurrently treated intracranial tumors, which was 0.91% (122 of 13,479). The onset of delayed postoperative hemorrhage ranged from the 5th to 23rd day after the operation; the median time of onset was the 8th day. The onset manifestation included signs of intracranial hypertension and/or meningeal irritation (71.4%), brain herniation (14.3%), seizures (9.5%), and syncope (4.8%). Neuroimages revealed hematoma in 11 cases and subarachnoid hemorrhage in 10 cases. The rehemorrhage rate was 38.1% (8 of 21). The mortality rate for delayed postoperative hemorrhage was 28.6% (6 of 21). None of the clinical parameters was correlated with delayed postoperative hemorrhage (p > 0.05), despite a relatively lower p value for adhesion to neurovascular structures (p = 0.096).

Conclusions. Delayed postoperative hemorrhage contributed to most of the postoperative hemorrhages in patients with intracranial epidermoid cysts and was a unique postoperative complication with unfavorable outcomes. Adhesion to neurovascular structures was possibly related to delayed postoperative hemorrhage (p = 0.096).

Abbreviations used in this paper: CPA = cerebellopontine angle; SAH = subarachnoid hemorrhage.

The definition of delayed postoperative hemorrhage comes from delayed posttraumatic hematoma.8,10 It is a radiological definition and means a hemorrhage that is unremarkable on the first postoperative CT scan but that manifests itself radiologically on one of the subsequent CT examinations. This definition best described a unique entity of postoperative hemorrhage in intracranial tumors. Delayed hemorrhage after intracranial tumor operation was reported for the first time in 2004.8

Postoperative hemorrhage in intracranial tumors has been reported, and most cases have occurred within 24 hours after the operation.13,20,27 However, most postoperative hemorrhages in epidermoids occur more than 72 hours postoperatively, after an initial unremarkable postoperative CT scan. The delayed onset of postoperative hemorrhage distinguishes epidermoids from other in-
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Intracranial tumors, and this unique feature makes delayed postoperative hemorrhage an entity worthy of investigation.

Aseptic meningitis after an operation is familiar to most neurosurgeons. However, delayed postoperative hemorrhage has not yet been reported due to its lower incidence (4.91%). Concerning the lower incidence of the epidermoid cyst itself, delayed postoperative hemorrhage has hardly been encountered or recognized in neurosurgical centers without enough epidermoid cases, which may be the reason that delayed postoperative hemorrhage has not been reported yet. This complication, with its delayed sudden onset and unfavorable outcomes, should be given more attention. In this study, we focused on delayed postoperative hemorrhage in intracranial epidermoids, reporting its incidence and clinical features, and analyzing possibly related clinical parameters.

Methods

Patient Characteristics

In all, 428 cases of intracranial epidermoid cysts were surgically treated and pathologically confirmed in our hospital between 2002 and 2008. The series included 195 male and 233 female patients. Their ages ranged from 2 to 69 years old; the mean was 36.6 ± 12.3 years (all means are expressed ± SD). All patients underwent routine admission examinations, including physical examination, laboratory investigation, electrocardiography, and chest x-rays. Patients with bleeding diseases or abnormal coagulation parameters were excluded.

Detection of Postoperative Hemorrhage in Epidermoid Cyst

A routine postoperative CT scan was obtained in each patient. Whenever a new neurological deficit or neurological deterioration (hemiparesis, aphasia, severe headache, seizure, significantly depressed level of consciousness) occurred—possibly due to underlying hemorrhage or edema—during the postoperative course, a CT scan was repeated immediately to search for the causes.

Postoperative hemorrhage was defined if the following items were both fulfilled according to the literature: 1) The postoperative CT scan revealed hemorrhage in the operative field; and 2) the patient suffered from a new neurological deficit or neurological deterioration, and/or CT scans showed space occupation by the hematoma. Acute postoperative hemorrhage was defined as occurring within 72 hours after the operation. Delayed postoperative hemorrhage was defined as occurring more than 72 hours after the operation in patients in whom the initial postoperative CT scan showed no intracranial hemorrhage.

Record of Clinical Material

The MR imaging and operative records of 428 patients with epidermoid were reviewed, and the following information was recorded: the patient’s age and sex, chief surgeon’s name, date of operation, tumor size, adhesion to peripheral neurovascular structures, and degree of resection. The chief surgeon’s experience was judged by the length of time he or she had been practicing neurosurgery. Tumor size was recorded according to the measurement of the maximal diameter on MR images. The adhesion to peripheral neurovascular structures was defined as adhesion or no adhesion according to operative records. The degree of resection was recorded as total, subtotal, or partial removal according to the degree of removal of the contents and capsule. Total removal was defined as complete removal of both the contents and capsule. Subtotal removal was defined as complete removal of the contents but incomplete removal of the capsule. Partial removal was defined as incomplete removal of both the contents and the capsule.

Statistical Analysis

The Student t-test was used to compare the age and tumor size between patients with and without delayed postoperative hemorrhage. Data were proven to be normally distributed. Categorical outcomes were compared with chi-square analysis using statistical software (SPSS for Windows, version 13.0 [SPSS, Inc.]). Probability values were obtained using 2-sided tests, with statistical significance defined as p < 0.05.

Results

Clinical Features of Delayed Postoperative Hemorrhage After Operations for Epidermoid Cyst

Of the 428 cases, 24 cases of epidermoid cyst were complicated by postoperative hemorrhage, including 3 acute and 21 delayed hemorrhages, according to the diagnostic criteria. Thus, delayed bleeding accounted for 87.5% of the postoperative hemorrhages, and all were found more than 72 hours after the operation. The group of patients with delayed postoperative hemorrhage consisted of 9 male and 12 female patients, and the sex ratio was 0.75:1. The patients’ ages ranged from 19 to 55; the mean age was 39.1 ± 10.6 years. Epidermoid cysts were located in the parasellar region and/or CPA in 17 cases, in the fourth ventricle in 3 cases, and in the frontal lobe in 1 case. The clinical data are summarized in Tables 1 and 2.

The day of operation was defined as Day 0. The day after the operation was defined as the 1st postoperative day, and so on. The time of delayed postoperative hemorrhage ranged from the 5th to the 23rd day after removal of the epidermoid cyst; the median time of onset was the 8th day. The highest frequency of delayed postoperative hemorrhage was on the 6th and 7th days. Acute postoperative hemorrhage occurred within 24 hours after the operation, and delayed bleeding occurred more than 72 hours after the operation. The time distribution of postoperative hemorrhage is shown in Fig. 1.

Delayed onset of postoperative hemorrhage, with signs of intracranial hypertension and/or meningeal irritation such as sudden headache, nausea, vomiting, and stiff neck occurred in 15 (71.4%) of 21 cases; with signs of brain herniation such as conscious deterioration, change of respiration, and altered pupils in 3 cases (14.3%); with seizures in 2 cases (9.5%); and with syncope in 1 case (4.8%).
According to results of CT scanning, of 21 patients with delayed postoperative hemorrhage, 11 presented with hematoma (52.4%) and 10 presented with SAH (47.6%). Patients with a small hematoma and stable consciousness were treated conservatively, whereas patients with a large hematoma and deteriorating consciousness levels underwent emergency operations to remove these lesions. All patients with SAH were given conservative treatment.

Rehemorrhage occurred in 8 of 21 cases, with delayed postoperative bleeding a few days after the initial postoperative hemorrhage. The incidence of rehemorrhage was thus 38.1%, which was significantly higher than that of the initial hemorrhage (4.91%; p < 0.001). The onset of rehemorrhage varied, ranging from the 1st to the 9th day after the initial hemorrhage; the median time of onset was the 4th day. In 5 cases, the onset occurred with signs of intracranial hypertension, whereas the other 3 cases presented with deteriorating consciousness levels.

In the 21 patients with delayed postoperative hemorrhage, the mortality rate was 28.6% (6 of 21). The mortality rates in patients with hematoma and SAH were 27.3% (3 of 11) and 30% (3 of 10), respectively. The mortality rates in patients with the initial hemorrhage and rehemorrhage were 14.3% (3 of 21) and 37.5% (3 of 8), respectively.

### Incidences of Postoperative and Delayed Postoperative Hemorrhage in Patients With Epidermoid Cysts

Between 2002 and 2008 in our hospital, 13,479 cases of intracranial tumor were surgically treated, and 122 cases were complicated with postoperative hemorrhage. The incidence of this complication in all intracranial tumors was 0.91%. Over the same period, 428 cases of epidermoid cyst were surgically treated, and 24 of these cases were complicated with postoperative hemorrhage, including 3 with acute and 21 with delayed onset. The incidences of postoperative and delayed postoperative hemorrhage in epidermoid cysts were 5.61% and 4.91%, respectively, both of which were significantly higher than the incidence of postoperative hemorrhage in all concurrently treated intracranial tumors (p < 0.001).

### Analysis of Clinical Parameters Possibly Related to Delayed Postoperative Hemorrhage

We analyzed the relationship of delayed postoperative hemorrhage to several clinical parameters, including the patient’s age and sex, the chief surgeon’s experience in neurosurgery, the year in which the operation was performed, tumor size, adhesion to peripheral neurovascular structures, and degree of resection. The results of this analysis are summarized in Tables 3 and 4.

The chief surgeon’s experience was judged by the length of time he or she had been working as a neurosurgeon, and this experience ranged from 5 to 39 years; the mean was 22 ± 6.9 years. The chief surgeons were stratified into a junior level (5–20 years) and a senior level (21–39 years) according to their work experience in neurosurgery. The incidences of delayed postoperative hemorrhage in patients treated by junior- and senior-level surgeons were 5.79% and 4.20%, respectively. The differences were not significant (p = 0.450).

The year in which the operation was performed was...
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<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value (%)</th>
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<tbody>
<tr>
<td>age at diagnosis in yrs</td>
<td>mean 39.1 ± 10.6, range 19–55</td>
</tr>
<tr>
<td>sex</td>
<td>M 9 (42.9), F 12 (57.1)</td>
</tr>
<tr>
<td>tumor characteristics on imaging</td>
<td></td>
</tr>
<tr>
<td>tumor size in cm</td>
<td>mean 4.29 ± 1.08, range 2.3–6.1</td>
</tr>
<tr>
<td>location</td>
<td>parasellar &amp;/or CPA 17 (81.0), 4th ventricle† 3 (14.3), frontal lobe 1 (4.8)</td>
</tr>
<tr>
<td>tumor resection</td>
<td>total 7 (33.3), subtotal 13 (61.9), partial 1 (4.8)</td>
</tr>
<tr>
<td>symptoms at presentation of delayed hemorrhage</td>
<td>hypertension &amp;/or meningeal irritation 15 (71.4), brain herniation 3 (14.3), seizures 2 (9.5), syncope 1 (4.8)</td>
</tr>
<tr>
<td>postop onset of delayed hemorrhage</td>
<td>median 8th day, range 5th–23rd day</td>
</tr>
<tr>
<td>hemorrhagic mode</td>
<td>hematoma 11 (52.4), SAH 10 (47.6)</td>
</tr>
<tr>
<td>treatment</td>
<td>emergency op 8 (38.1), conservative treatment 13 (61.9)</td>
</tr>
<tr>
<td>rehemorrhage</td>
<td>8 (38.1)</td>
</tr>
<tr>
<td>outcome</td>
<td>death 6 (28.6), disability 2 (9.5), recovery 13 (61.9)</td>
</tr>
</tbody>
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* All means are expressed ± SD.
† Case 11 is included because the tumor was mainly located in the fourth ventricle, despite the involvement of the CPA.

The development of microscopic equipment. To analyze the relationship of delayed postoperative hemorrhage and microscopic equipment, the operation dates were divided into early phase (2002–2005) and late phase (2006–2008) groups. The incidences of delayed postoperative hemorrhage in the 2 phases were 4.48% and 5.37%, respectively, and the difference was not significant (p = 0.673).

The incidences of delayed postoperative hemorrhage in male and female patients were 4.62% and 5.15%, respectively; the difference was not significant (p = 0.799). The mean ages of the patients with and without delayed postoperative hemorrhage were 39.1 ± 10.6 years and 36.4 ± 12.4 years, respectively. The difference was not significant (p = 0.228).

Tumor size was recorded as maximal diameter according to the measurement on MR images. The mean tumor sizes in patients with and without delayed postoperative hemorrhage were 4.29 ± 1.08 cm and 3.93 ± 1.34 cm, respectively. The difference was not significant (p = 0.228).

Most of the tumors showed adhesion to peripheral neurovascular structures. The incidences of delayed postoperative hemorrhage in tumors with and without adhesion were 6.06% and 2.29%, respectively; the difference was not significant (p = 0.096).

Due to the cheeselike consistency of the cyst contents, total removal was achieved in 189 cases (44.2%), subtotal removal was achieved in 238 cases (55.6%), and partial removal was performed in only 1 case (0.2%). The incidences of delayed postoperative hemorrhage in totally removed and subtotally removed epidermoids were 3.70% and 5.86%, respectively. The difference was not significant (p = 0.306).

None of the parameters reached a significantly different level (p > 0.05). However, the adhesion to neurovascular structures might be a parameter that was possibly related to delayed postoperative hemorrhage, due to the lower p value (p = 0.096).

**Illustrative Cases**

**Case 1**

This 46-year-old man with radiological diagnosis of epidermoid cyst in the right frontal lobe (Fig. 2A) underwent right frontal craniotomy to remove the lesion. During the operation, tumor was found in the medial area of the right frontal lobe, measuring 5 × 4 × 3 cm. The capsule was thick and partially calcified. Both the capsule...
and its cheeselike contents were completely removed. The patient was stable postoperatively, and a CT scan obtained 6 hours after the operation showed no hemorrhage (Fig. 2B). However, he suffered from sudden headache, nausea, and vomiting on the 8th day after the operation. Neurological examination showed consciousness disturbance, unequal pupils, and negative light reflex. An emergency CT scan revealed a hematoma in the operative field (Fig. 2C), and an emergency operation was performed to remove the lesion. During the operation, active bleeding was found in the branch of the pericallosal artery deep in the hematoma. Careful hemostasis was performed. The patient was discharged after attaining good postoperative recovery (Fig. 2D).

Case 5

This 54-year-old woman with radiological diagnosis of epidermoid cyst in the right CPA (Fig. 3A–C) underwent right temporococcipital craniotomy to remove the lesion. During the operation, after removal of the cyst contents, the capsule was found to be partially adhered to neurovascular structures. The capsule was carefully detached from peripheral neurovascular structures. The initial postoperative CT scan showed no hemorrhage (Fig. 3D). However, the patient suffered from sudden headache on the 10th day after the operation, and an emergency CT scan showed a hematoma in the operative field (Fig. 3E). She was treated conservatively and recovered smoothly from the hemorrhage (Fig. 3F).

Case 10

This 31-year-old man was admitted with the diagnosis of recurrent epidermoid cyst in the left CPA (Fig. 4A–C) and underwent a left temporoparietal craniotomy. The lesion was subtotally removed. During the operation, the capsule was found to be strongly adhered to the brainstem and basilar artery, and the contents wrapped the oculomotor nerve, basilar artery, and its branches. The cyst contents were completely removed, and the capsule was partially removed. A CT scan obtained 6 hours after the operation showed no hemorrhage (Fig. 4D). However, on the 9th day after the operation, the patient suddenly suffered from unbearable headache followed by respiratory arrest. His respiration was assisted by a ventilator, and neurological examination showed negative light reflex. An emergency CT scan showed SAH in and around the operating field (Fig. 4E and F). Respiration was maintained by a ventilator, and the patient died 4 days later.

Case 15

This 30-year-old man, who was admitted with radiological diagnosis of epidermoid cyst in the right CPA, reported dysfunctional abduction of the right eyeball with double vision for 6 months and a swallowing disturbance for 1 month. Neurological examination revealed dysfunction of the 6th, 7th, and 9th–12th cranial nerves. Radiological investigation showed a lesion occupying the right CPA (Fig. 5A). The patient’s blood pressure was normal, and he did not have hemorrhagic diseases. His platelet count, activated partial thromboplastin time, and prothrombin time were normal. During the operation, the 6th–12th cranial nerves and petrosal vein were all found to be wrapped in the tumor. Total removal could not be achieved due to strong adhesion of the capsule to the brainstem. The patient therefore underwent subtotal removal of the tumor, and the initial postoperative CT scan showed no hemorrhage (Fig. 5B). Uneventful recovery was disturbed by sudden headache, nausea, and vomiting on the 7th day after the operation. An emergency CT scan showed a hematoma in the operative field (Fig. 5C). On completion of the CT scan, the patient’s respiration arrested and his breathing was assisted by a ventilator. An emergency operation was performed immediately, and active bleeding was found on the petrosal vein after removing the hematoma. Careful hemostasis was performed. Postoperative CT scans showed no hematoma (Fig. 5D). However, coma occurred in this patient again on the 7th day after removal of the hematoma, and an emergency CT scan verified rehemorrhage in the operative field (Fig. 5E). The second emergency operation was performed, and actively bleeding vessels were found in the operative field after removal of the hematoma. Careful hemostasis was again performed. The patient finally recovered from the hematoma and was discharged after these emergencies (Fig. 5F).
Case 21

This 31-year-old woman, who had undergone craniotomy for epidermoid 7 years earlier, was admitted with the diagnosis of recurrent epidermoid in the right CPA. She complained of right-sided facial numbness that had been present for 1 year. Her radiological examination showed a lesion occupying the right CPA (Fig. 6A and B). The patient underwent subtotal removal of the tumor, and a postoperative CT scan showed no hemorrhage (Fig. 6C). However, sudden consciousness disturbance and incontinence occurred in this patient on the 7th day after the operation. Neurological examination revealed that the patient was comatose, with unequal pupils and positive
Babinski sign on the right side. An emergency CT scan showed hemorrhage in the operative field (Fig. 6D), and an emergency operation was performed to remove the hematoma. During the operation, no obvious bleeding vessels were found. After the operation, the patient gradually recovered and was discharged (Fig. 6E). Pathological examination of resected tissue confirmed the diagnosis of epidermoid cyst (Fig. 6F).

**Discussion**

Preoperative spontaneous hemorrhage, which is attributed to the formation of granulation tissue due to the leakage of irritant cyst contents, has been occasionally reported.\(^2,3,10,12,15,22,23,25,26\) However, our experience with epidermoid cyst suggests that it is distinguished from other tumors not only in preoperative but also in postoperative hemorrhage, especially in delayed postoperative hemorrhage. In our study, delayed postoperative hemorrhage was proposed, with illustrative cases presented here, and showed a trend toward being related to cyst adhesion to neurovascular structures according to our analysis.

**Incidence and Clinical Features of Delayed Postoperative Hemorrhage in Patients With Epidermoid Cysts**

Delayed postoperative hemorrhage contributed to 87.5% of postoperative hemorrhages identified in our study and is a unique postoperative complication in epidermoids. According to the literature, the incidence of postoperative hemorrhage for intracranial tumors ranged from 0.8% to 4.3%.\(^9,13,18,24\) The incidence decreased from 6.2% to 7.1% in meningiomas,\(^8,16\) to 2.6% in aneurysms,\(^18\) and to 2.2% in schwannomas.\(^19\) According to the analysis detailed here, the incidence of postoperative hemorrhage in all intracranial tumors was 0.91% in patients treated in our hospital. The incidence of postoperative hemorrhage and delayed postoperative bleeding in epidermoid cysts was 5.61% and 4.91%, respectively. In our study, 87.5% of postoperative hemorrhages in epidermoid cysts were delayed and occurred more than 72 hours after the operation, whereas most postoperative hemorrhages in other intracranial tumors occurred within 24 hours after the operation.\(^13,20,27\) This implied a quite different pathogenesis of delayed postoperative hemorrhage in epidermoids compared to that in other tumors. The reported mortality rate in patients with postoperative hemorrhage was 27.5%–32%,\(^15,18,24\) whereas the mortality rate in those with delayed postoperative hemorrhage after treatment for epidermoids was 28.6%.

Delayed postoperative hemorrhage exhibited unique clinical features. The onset of delayed bleeding ranged from the 5th to the 23rd day after the operation; the median

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**Fig. 4.** Case 10.  **A and B:** Axial T1- and T2-weighted MR images demonstrating a space-occupying lesion in the left parasellar region.  **C:** Diffusion-weighted MR image showing diffusing disturbance.  **D:** Axial CT scan demonstrating no hemorrhage 6 hours after removal of the lesion.  **E and F:** Axial CT scans demonstrating SAH on the 9th day after removal of the lesion.
time of onset was the 8th day. Most of the delayed postoperative hemorrhages occurred within 2 weeks postoperatively (19 of 21 hemorrhages), and the frequency was the highest on the 6th and 7th days (10 of 21) (Fig. 1). Onset of rehemorrhage ranged from the 1st to 9th day after initial bleeding; the median time of onset was the 4th day. The onset manifestation of delayed postoperative hemorrhage involved mainly signs of intracranial hypertension, meningeal irritation, and brain herniation. Deterioration was rapid in some cases. A method for preventing delayed postoperative hemorrhage was unknown. The only thing we could do was closely monitor the patient postoperatively. Whenever a new neurological deficit or deterioration occurred and an occult hematoma or brain edema was suspected, CT scanning should be performed immediately to find the causes. On confirming the diagnosis of delayed postoperative hemorrhage in epidermoids, more attention should be given. Different therapeutic strategies can be chosen according to bleeding modes, volume, and consciousness levels. Large or increasing hematoma with deteriorating consciousness levels requires an emergency operation, whereas a small hematoma with a stable consciousness level is an indication for conservative treatment. During conservative treatment, consciousness and bleeding volume should be monitored closely. Deteriorating consciousness or increasing bleeding volume requires an emergency operation to remove the hematoma instead of further conservative treatment. For delayed SAH, conservative treatment can be chosen for most cases, whereas surgery was indicated when severe hydrocephalus or brain edema occurred.

Pathogenesis of Delayed Postoperative Hemorrhage in Epidermoid Cysts

According to the literature, the pathogenesis of postoperative hemorrhage for intracranial tumors includes abnormal coagulation, history of hypertension, and abrupt rise of blood pressure during the late stage or immediately after the anesthesia, surgical manipulations, brain shift, and a large amount of blood loss. Acute postoperative hemorrhage can be attributed to these causes. However, delayed postoperative hemorrhage of epidermoid cysts cannot be reasonably attributed to any of the reasons given above, due to its delayed onset. Other factors may account for this unique complication.

We analyzed parameters that were possibly related
to delayed postoperative hemorrhage. The parameters were compared in patients with and without this condition, and included the patient’s age and sex, the chief surgeon’s experience, year of the operation, tumor size, adhesion to pericystic neurovascular structures, and degree of resection. None of the parameters showed a significant correlation with delayed postoperative hemorrhage ($p > 0.05$). However, the relatively lower $p$ value (0.096) distinguished adhesion to neurovascular structures from other parameters as a factor that was possibly related to delayed postoperative hemorrhage.

This entity cannot be reasonably attributed to surgical strategy alone, according to our experience and the literature. First, most surgery-related hemorrhages occurred within 24 hours as acute postoperative hemorrhage, whereas all the cases of delayed bleeding occurred more than 72 hours postoperatively. Second, surgery-related injury had been excluded according to the operation records and postoperative CT scan. Third, preoperative spontaneous hemorrhages do exist according to our observation and the literature review. Fourth, no correlation was found between delayed postoperative hemorrhage and surgery-related parameters such as the chief surgeon’s experience, year of the operation, and degree of resection. Generally speaking, if the complication has some relationship with the surgical strategy, the incidence of the complication will decline with enrichment of the chief surgeon’s experience and the development of microscopic equipment. However, the incidences of delayed postoperative hemorrhage were not significantly different between the junior and senior chief surgeon groups or between early and late phases ($p > 0.05$).

The presence of adhesions might have a relationship with delayed postoperative hemorrhage. The leakage of irritant contents outside the capsule resulted in the adhesion to neurovascular structures, which was unique for epidermoids. The adhesion leads to formation of granulation tissue and change of pericystic neurovascular structures. The granulation tissue or the changed vessels were 2 possible focuses for delayed postoperative hemorrhage. The granulation tissue with hemorrhage may be one of the risk factors in the pathogenesis of delayed postoperative hemorrhage. Adhesion to neurovascular structures is due to the formation of granulation tissue between them, and it is responsible for subtotal or partial removal of epidermoids. A remnant of the capsule with

![Fig. 6. Case 21. Axial T2-weighted (A) and sagittal T1-weighted (B) MR images demonstrating a space-occupying lesion in the right CPA. C: Axial CT scan showing no hemorrhage 6 hours after removal of the lesion. D: Axial CT scan demonstrating delayed postoperative hemorrhage on the 7th day after removal of the lesion. E: Axial CT scan obtained several hours after removal of the hematoma. F: Photomicrograph of tissue obtained for pathological examination showing epidermoid cyst consisting of keratin and epithelium. H & E, original magnification × 100.](image)
granulation tissue may be responsible for the delayed hemorrhage. Spontaneous preoperative hemorrhage in epidermoids has been reported and is attributed to the vascularity in the granulation.\(^2,10,12\) The pathogenesis of delayed postoperative hemorrhage may be similar to that of spontaneous preoperative hemorrhage.

Degeneration of pericystic blood vessels due to the irritant contents of the cyst may be another risk factor for the delayed hemorrhage. Tomlinson and Walton\(^2\) reported that the dissemination of the degradative products of an intracranial epidermoid cyst throughout the subarachnoid space resulted in diffuse degenerative changes in the CNS. Also, a case of ruptured suprasellar dermoid cyst associated with a middle cerebral artery (specifically, M\(_1\)) aneurysm and stenosis of adjacent arterial trunks was reported by Ahmad et al.,\(^1\) who speculated that weakness of the arterial branches during the inflammatory process leads to aneurysm formation. Ecker et al.\(^4\) reported that ruptured dermoid cysts are a risk factor for early and delayed cerebral ischemia, and endovascular treatment of dermoid-encased vessels may carry a higher risk for rupture. Therefore, it was speculated that the chemical degenerative effects of irritant contents to pericystic blood vessels resulted in degeneration of the vessel wall and eventual rupture due to the pulsating of blood, which further resulted in delayed postoperative hemorrhage in epidermoids.

The bleeding vessels found in the operative field during removal of hemATOMA were another provocative bit of evidence for this hypothesis. Not only arterioles but also venules were responsible for the hemorrhage in 5 cases. Preoperative leakage outside the cyst wall and/or postoperative remnant of irritant contents increases the probability of chemical erosion of pericystic vessels by irritants in the cyst contents. Therefore, total removal of epidermoid cyst, irrigation of the operative field with normal saline with the addition of dexamethasone, coverage of the pericystic operative field with hemostatic gauze, and continuous CSF drainage for 48–72 hours after the operation are recommended to prevent delayed postoperative hemorrhage. The effects of these procedures will be evaluated in the near future.

Despite the foregoing speculation, the exact pathogenesis of delayed postoperative hemorrhage in epidermoid cysts still needs further investigation. Elucidation of the pathogenesis of delayed postoperative hemorrhage will help minimize this lethal complication.

Conclusions

The incidence of postoperative hemorrhage (5.61%) was significantly higher than that of concurrent intracranial tumors (0.91%) and was mainly composed of delayed postoperative hemorrhage (87.5%). This entity is a unique complication of epidermoid cysts with unfavorable outcomes, of which the surgeon should be aware if neurological deficit or deterioration occurs around the 5th–23rd day postoperatively, despite previous negative CT scans. Clinical parameters, including the patient’s age and sex, the chief surgeon’s experience, year of operation, tumor size, adhesion to neurovascular structures, and degree of resection were reviewed and compared in patients with and without delayed postoperative hemorrhage. None of these parameters were correlated with this entity (p > 0.05). However, the relatively lower p value (0.096) distinguished adhesion to neurovascular structures as a factor that is possibly related to delayed postoperative hemorrhage.

Disclosure

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Address correspondence to: Song Lin, M.D., Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Tiantan Xili No. 6, Beijing 100050, China. email: linsong2005@126.com.