CLINICAL ARTICLE

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# Risk Factors of Postoperative Hematomas after Surgery for Intracranial Meningiomas

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**Objective :** Meningioma is a benign tumor which has a high occurrence rate of postoperative hematomas. The purpose of this study is to analyze risk factors for postoperative hemorrhages after meningioma surgery.

**Methods :** One hundred and fifty three patients with intracranial meningiomas, operated at the Department of Neurosurgery, National Medical Center, between January 1995 and December 2003 were included in this retrospective study. Risk factors considered to be related with postoperative hematomas were age, sex, preoperative pharmacological anticoagulants for medical co-morbidity, tumor location, histological type of the meningioma, infiltration of dural sinus and arachnoid, removal range of tumors, and the perioperative coagulation status including prothrombin time, partial thromboplastin time, and platelet count.

**Results :** Patients' aged more than 70 years with a platelet count of less than $150 \times 10^9 \ell^{-1}$ after surgery had statistically significant relations to the occurrence rate of postoperative hematomas. The other factors had no statistical significance.

**Conclusion :** Various and intensive preoperative examinations for coagulation factors of patients, especially of older age, and proper transfusion before meningioma surgery are necessary for preventing postoperative hematoma.

**KEY WORDS :** Meningioma · Postoperative hematoma · Old age · Platelet count.

## Introduction

Intracranial meningiomas are approximately 15~20% of all intracranial tumors. The choice of treatment for intracranial meningiomas is surgical resection, because more than 90% of these tumors are histologically benign and can be removed completely[5,12,14,21]. Risk factors associated with poor postoperative prognosis are poor preoperative clinical condition, old age, incomplete tumor removal, and pulmonary embolism[15,18,21]. Among these risk factors, the occurrence of postoperative hematomas has been shown to be significantly related to a higher mortality[2,21]. In other studies of patients who underwent surgery to remove brain tumors, meningioma surgery had the highest occurrence rate of postoperative intracranial hematomas[10,18,21]. The occurrence rate of postoperative hematomas and complications related to hemorrhages after meningioma surgery derived from the literature is about 4%, 6%, 7%, and 10%[6,13,18,21]. The aim of this study was to identify the risk factors associated with postoperative hematomas and to prevent postoperative hematomas and decrease the occurrence rate by identifying avoidable causes of postoperative hematomas before meningioma surgery.

## Materials and Methods

One hundred and fifty three patients with intracranial meningiomas, operated at the Department of Neurosurgery, National Medical Center, between January 1995 and December 2003 were included in this study. Postoperative hematomas were defined in this study as the hematomas occurring after removal of intracranial meningiomas and the operative removal of hematomas was performed only in the case of the hematomas which had mass effect in postoperative CT and induced neurological disturbance of consciousness. Meningioma surgery was planned as an elective procedure and therefore anticoagulants were stopped at least one week before surgery in all patients. A preoperative prothrombin time of more than 80%, a partial thromboplastin time of less than 40 sec, and platelets of more than $150 \times 10^9 \ell^{-1}$ were considered to be sufficient for hemostasis. Standard microsurgical

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techniques were applied for the removal of tumors. Risk factors retrieved retrospectively of postoperative hematomas were age, sex, preoperative pharmacological antithrombotic medication for medical co-morbidity, location and histological type of the meningiomas, infiltration of dural sinus and arachnoid, removal range of tumors (Simpson's grade), and the perioperative coagulation status including prothrombin time, partial thromboplastin time, and platelet count.

The Z test and Chi square test were used in statistical evaluation, and $p<0.05$ was considered to be significant.

## Results

### Age and sex (Table 1)

15 patients (9.8%) of 153 patients developed postoperative hematomas. Patients who had postoperative hematomas were at statistically significantly higher age (67.4±11.0) compared to patients without postoperative hematomas (52.1±13.0 ; $P<0.05$). Patients at the age of 65 years or younger did not show a significant difference. However, patients older than 70 years had a seven-fold increased risk of developing postoperative hematomas. Patients older than 75 years had a twelve-fold higher risk of postoperative hematomas. There was a high occurrence rate (25%) of postoperative hematomas in patients younger than 40 years. However, it was impossible to show a statistical significance because there were only 3 cases of patients younger than 40 years.

The ratio between male and female was 1:1.2 with hemorrhage and 1:1.5 without hemorrhage. There was no statistical significance.

### Preoperative use of anticoagulants (Table 2)

Thirty-four patients had taken anticoagulants. Three (8.8%) developed postoperative hematomas. There was no statistical significance between preoperative anticoagulant medication and the occurrence of postoperative hemorrhages.

**Table 1.** Age distribution

| Age | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| <41 | 4 | 1 | 25.0 |
| 41-50 | 39 | 2 | 5.1 |
| 51-60 | 27 | 2 | 7.4 |
| 61-70 | 41 | 3 | 7.3 |
| >70 | 42 | 7 | 16.7 |
| Total | 153 | 15 | 9.8 |

**Table 2.** Preoperative use of anticoagulants

| Preoperative | Anticoagulants | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|---|
| Yes | Aspirin | 30 | 2 | 6.7 |
| | Wafarin | 4 | 1 | 25.0 |
| No | | 119 | 12 | 10.1 |
| Total | | 153 | 15 | 9.8 |

### Locations (Table 3) and histological subtypes (Table 4)

In patients with postoperative hemorrhages, retroclival meningioma had the highest occurrence rate (33.3%), with meningioma at the cerebellopontine angle (16.7%), convexity (10.1%), and falx/parasaggital (9.6%) next in occurrence. There was no significant association between postoperative hematomas and location because there were only 3 postoperative hemorrhage patients with retroclival meningioma.

Table 4 shows the occurrence rate according to histological subtypes : anaplatic (12.5%), atypic (11.4%), angiomatous (11.1%), and fibrous (10.5%) meningiomas developed postoperative hematomas. There was no significant association between postoperative hematomas and histological subtype.

### Invasion to dural sinus (Table 5) and arachnoid infiltration (Table 6)

The data for invasion to dural sinus and arachnoid infiltration were based on the operation records. Postoperative hematomas developed in the case of invasion to sinus (9.9%) and no invasion (9.5%) (Table 5). There was no statistical significance between them.

Table 6 shows postoperative hematomas with arachnoid

**Table 3.** Locations of the meningiomas

| Location | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| Convexity | 59 | 6 | 10.1 |
| Falx/parasaggital | 31 | 3 | 9.6 |
| Sphenoidal ridge | 27 | 2 | 7.4 |
| Lateral ventrical | 1 | 0 | 0.0 |
| Tentorium | 14 | 1 | 7.1 |
| Cerebellopontine angle | 6 | 1 | 16.7 |
| Olfactory groove | 12 | 1 | 8.3 |
| Retroclival | 3 | 1 | 33.3 |
| Total | 153 | 15 | 9.8 |

**Table 4.** Histologic subtypes of the meningiomas

| Histologic subtype | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| Meningotheliomatous | 55 | 5 | 9.1 |
| Fibrous | 19 | 2 | 10.5 |
| Transitional | 20 | 2 | 10.0 |
| Angiomatous | 9 | 1 | 11.1 |
| Psammomatous | 6 | 0 | 0.0 |
| Clear cell | 1 | 0 | 0.0 |
| Atypic | 35 | 4 | 11.4 |
| Anaplastic | 8 | 1 | 12.5 |
| Total | 153 | 15 | 9.8 |

infiltration of meningiomas which was 11.5% and 9.4% without infiltration. No significant difference was seen between them.

### Extent of tumor removal (Table 7)

Simpson's grading system was applied to classify the extent of tumor removal. Incidence of hematoma was grade IV (22.2%), III (14.3%), II (11.1%), and I (8.5%). There was no statistical significance between postoperative hemorrhage occurrence rate and Simpson's grading system even though there was a small positive correlation of hematoma incidence and Simpson's grading system.

### Standard coagulation parameters (Table 8)

There was no significant difference between patients with postoperative hematomas and those without hemorrhages in preoperative standard coagulation parameters. However, from examinations immediately after surgery, patients with post-operative hematomas had significantly lower levels of prothrombin time (79.4±13.1 versus 70.6±11.3) and platelet count (185.6±50.3 versus 115.6±45.3) compared to patients without postoperative hematomas. Hematocrit showed no difference between the two groups. No difference in hematocrit means there is no difference in hemodilution. Patients with platelet count lower than $150 \times 10^9 \ell^{-1}$ had a sixteen-fold higher risk of postoperative hematomas ($P<0.02$).

**Table 5.** Invasion of venous sinus

| Invasion of venous sinus | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| Non-invasion | 132 | 13 | 9.9 |
| Invasion | 21 | 2 | 9.5 |
| Total | 153 | 15 | 9.8 |

**Table 6.** Arachnoid infiltration

| Arachnoid infiltration | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| Non-infiltration | 127 | 12 | 9.4 |
| Infiltration | 26 | 3 | 11.5 |
| Total | 153 | 15 | 9.8 |

**Table 7.** Extent of tumor removal

| Simpson's grade | Total No. of patients | Post-operative hemorrhage | Incidence(%) |
|---|---|---|---|
| 0 | 55 | 5 | 9.1 |
| I | 71 | 6 | 8.5 |
| II | 9 | 1 | 11.1 |
| III | 7 | 1 | 14.3 |
| IV | 9 | 2 | 22.2 |
| V | 2 | 0 | 0.0 |
| Total | 153 | 15 | 9.8 |

**Table 8.** Perioperative coagulation parameters

| Coagulation parameter | Preoperative | | Immediately postoperative | |
|---|---|---|---|---|
| | No postoperative hematoma | Postoperative hematoma | No postoperative hematoma | Postoperative hematoma |
| PT (%) | 96.4 ± 10.5 | 96.7 ± 13.2 | 79.4 ± 13.1 | 70.6 ± 11.3 |
| aPTT (sec) | 31.2 ± 4.5 | 30.7 ± 4.2 | 32.6 ± 3.7 | 33.2 ± 6.5 |
| PLTs ($X\ 10^9\ 1^{-1}$) | 266.3 ± 23.9 | 277.6 ± 50.1 | 185.6 ± 50.3 | 115.6 ± 45.3 |
| Htc (%) | 41.2 ± 5.2 | 42.1 ± 5.0 | 30.5 ± 3.8 | 31.2 ± 3.5 |

## Discussion

A postoperative hematoma after brain surgery is one of factors which has serious consequence the patient's outcome[10,14,15,18,21]. Removal of an intracranial meningioma carries a higher risk of postoperative hematoma compared to surgery for other brain tumors[10,12,18,21]. In our study, the rate was 9.8%. In the literature, hyperfibrinolysis derived from meningiomas is one of the reasons that meningioma surgery has a higher occurrence rate of postoperative hematomas compared to surgery for other benign brain tumors[12,18].

Many authors reported the risk factors which could cause postoperative hematomas after meningioma surgery. Among those authors, Rudiger et al.[21] clinically analyzed the factors. In Rudiger's study, there was a higher occurrence of postoperative hematomas in older patients compared to younger patients. However, there was no statistical significance in the relation between postoperative hematomas and any other factors related to tumors and operations. Also, Arnaudova et al.[1] reported that there was also a higher occurrence rate of postoperative hematomas in older patients, in addition to total excision compared to partial removal, and convexity meningiomas compared to other locations. However, there was no statistical significance between the occurrence of postoperative hemorrhages and the range of removal and locations in our study. These differences need further discussion.

The outcome in this study corresponded to that of Rudiger et al.[21]. Interestingly patients with postoperative hematomas were older compared to patients without hematomas in the above three studies. To our knowledge there is no obvious reason for this in the literature. Why is there a higher possibility of postoperative hematomas in older patients? Vascular degeneration and decrease of platelet function according to age may be the reason for the increased occurrence of hemorrhages. Unfortunately, there was no data related to platelet function in our study. Regarding changes in coagulation factors, Boldt et al.[3] stated that thrombin generation and neutralization are accelerated, and platelet function is decreased in older patients compared to youngers from a study of

patients who underwent major abdominal surgery. They stated that the continuous activation of the coagulation system causes an imbalance of the hemostatic system resulting in postoperative hemorrhages.

In our study, the platelet count of patients with postoperative hematomas significantly decreased compared to that of patients without. Even though there was direct relation between platelet count and the occurrence rate of postoperative hemorrhages, the threshold of platelet count was not reported[4,8]. Fellin et al.[7] stated platelet count must be maintained above 100,000/$\mu\ell$. However, Pulliam et al.[20] suggested that a count of 50,000 to 70,000/$\mu\ell$ was enough to prevent postoperative hematomas. In our study, patients with a platelet count lower than 150,000/$\mu\ell$ before surgery or lower than 100,000/$\mu\ell$ immediately after surgery had partial platelet transfusions. Postoperative hematomas significantly increased in patients with platelet counts lower than 150,000/$\mu\ell$ after surgery. Chan et al.[4] stated that the occurrence rate of postoperative hematomas in patients with a platelet count lower than 125,000/$\mu\ell$ after surgery increased sharply. An other cause of coagulation dysfunction related to postoperative hematomas was dysfunction of coagulation factor XIII in other studies[9]. However we did not obtain data for coagulation dysfunction. In other studies aspirin and warfarin had a close connection with postoperative hematomas[8,19]. In our study the data for the relation between anticoagulants and postoperative hematomas was not obtained. However, statistical analysis is needed in further studies.

From comparing and analyzing many studies, the mechanism and trigger factors of postoperative hematomas after meningioma surgery remain debatable. To improve treatment results and the prognosis of patients with meningiomas, the mechanism and risk factors of postoperative hemorrhages need further study.

## Conclusion

We performed a statistical test to discover the causes of postoperative hematomas after meningioma surgery in relation to several factors and various methods. We have shown that the occurrence of postoperative hematomas was increased by older patient age, more than 65 years, and lower platelet count after surgery, below 150,000/$\mu\ell$. However, sex, preoperative medication of thrombolytics and anticoagulants, anatomical location of tumors, histological subtype, invasion to dural sinus, arachnoid infiltration, and extent of tumor removal were not statistically related to the occurrence of postoperative hematomas. To decrease the incidence of postoperative hemorrhages after meningioma surgery, a number of intensive perioperative examinations for coagulation factors and proper transfusion must to be performed.

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## Commentary

I am very excited with your interest in the article. Thank you for your opinions and questions about recurrences of chronic SDH(CSDH).

At first, we experienced only three cases of recurrences. One case recurred within a month after burrhole drainage. He recovered spontaneously without operation. He just needed some analgesics due to headache. We didn't know the cause of recurrence of this case. But his recurred hematoma was low density, so it was, in fact, fluid collection rather than real hematoma. Another case has had hyperdense hematoma preoperatively and the hematoma changed hypodense postoperatively. But the thickness of the hematoma was not reduced enough. Otherwise, the brain didn't re-expand enough, so the adhesion of the membrane didn't occur, I think. The last one has had mixed hematoma, hyperdense and isodense. The brain re-expansion didn't occur enough either. About the brain re-expansion, the age is the important factor[1]. Maybe the age of the last two cases affects the recurrence.

Second, re-bleeding is the important mechanism in recurrence. If the adhesion doesn't occur, re-bleeding can occur from outer membrane. In that means, postoperative fluid collection is very important in recurrence. If the thickness of fluid collection is not reduced, it can induce re-bleeding, i.e. recurrence.

Lastly, saline injection was not performed routinely in our institute. But I think it cannot reduce the recurrence. More investigation can be needed with new aspect about that. Postoperative air collection was common finding in our experience. It resolved spontaneously in all cases. I think it may not be the problem in recurrence. I agree with your opinion about high density after operation. I also think it might be re-bleeding or mixed oozed blood.

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