Wrapping of Intracranial Aneurysms with Gauze Sponge

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Abstract

A gauze sponge wrapping method to prevent recurrent subarachnoid hemorrhage (SAH) after incomplete obliteration of intracranial aneurysm or a residual neck after clipping was developed and tested. The authors performed the gauze wrapping for aneurysms with incomplete obliteration by clipping alone, abnormal changes of the parent artery wall which had the possibility of regrowth or re-rupture, and surgical difficulties. The residual neck of the aneurysm or the abnormal arterial wall was tightly and completely wrapped, including the parent artery, and cemented with plastic adhesive. Seventy-eight (22.3%) of 349 surgically treated aneurysms were treated by gauze wrapping (26 wrapping only, 52 clipping and wrapping). The incidence of complications such as infection, angiospasm, and normal pressure hydrocephalus, and the clinical outcome were not significantly different for the wrapping and non-wrapping groups. No recurrent SAH was observed in the wrapping group during 3 months to 8.5 years follow-up. These results suggest that wrapping with gauze sponge is useful in the treatment for ruptured aneurysms which cannot be totally obliterated.

Key words: cerebral aneurysm, subarachnoid hemorrhage, surgical treatment, wrapping, gauze sponge

Introduction

Neck clipping is the best treatment for intracranial aneurysms. When clipping is technically impossible, the aneurysm wall can be wrapped or coated. However, the best method for reinforcing the aneurysm wall has yet to be established. Incomplete obliteration of an aneurysm or a residual aneurysmal neck may result in recurrent hemorrhage.6,7,10,13,19 Most reported cases received inadequate reinforcement of the aneurysmal neck.

We report our experience of wrapping in cases with difficulty in the aneurysmal clipping, incomplete obliteration of the aneurysm by clipping alone, or the abnormal changes of the parent artery wall. We used gauze sponge for wrapping because it has good plasticity and provides firm encasement.5,17

Patients and Methods

We treated 270 patients with 349 aneurysms between 1979 and 1987. Hunt and Kosnik grade 0–III patients and patients with intracerebral hematoma were surgically treated in the acute stage (most within 3 days after hemorrhage). Most grade IV and V patients were treated more than 14 days after onset. The clinical outcome was assessed using the Glasgow Outcome Scale (GOS) score.

All patients received general anesthesia with endotracheal intubation and controlled respiration. Hypotension was induced during manipulation of the aneurysm and the surrounding area. D-mannitol was used routinely to reduce brain volume. A surgical microscope was used in all cases.

We performed gauze wrapping in patients with the following findings at operation or angiography; 1) obliteration of the aneurysm was technically impossible or incomplete, 2) the wall of the parent artery appeared abnormal (minute protrusion, thinning of the arterial wall, arteriosclerotic plaque, junctional dilatation) and could possibly become the site of an
aneurysm or rupture.

The aneurysm and parent artery were firmly and completely invested and the gauze fixed with plastic adhesive (Biobond®; EDH adhesive, Yoshitomi Pharmaceuticals, Osaka) to prevent the postoperative displacement of gauze-sponge and regrowth of aneurysm.

Evaluation of our wrapping method was based on the incidence of postoperative angiospasm, meningitis, and normal pressure hydrocephalus and the clinical outcome. Postoperative angiography was not performed because it is not free of risk.

Results

I. Patients

There were 93 males (34.4%) and 177 females (65.6%) with ages ranging from 19 to 77 years (mean 53.8 years, one patient was 12-months-old). Sixty-three patients had multiple aneurysms (23.3%). The aneurysms were treated with clipping alone in 266 (76.2%), clipping and wrapping in 54 (15.5%), and wrapping alone in 24 (6.9%) (including 20 non-ruptured aneurysms). Direct surgery was impossible in five aneurysms (1.4%) so carotid ligation and superficial temporal artery-middle cerebral artery (STA-MCA) anastomosis were performed. Wrapping was most frequently used in MCA aneurysms (Table 1) because these present more frequently with a broad base or junctional dilatation.

Table 1 Location and treatment of aneurysms

<table>
<thead>
<tr>
<th>Location</th>
<th>Wrapping with or without clipping</th>
<th>Clipping or ligation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal carotid artery</td>
<td>22</td>
<td>124</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>41</td>
<td>45</td>
</tr>
<tr>
<td>Anterior cerebral artery</td>
<td>14</td>
<td>90</td>
</tr>
<tr>
<td>Vertebrobasilar system</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>78</td>
<td>271</td>
</tr>
</tbody>
</table>

Table 2 Hunt and Kosnik grading of subarachnoid hemorrhage on admission

<table>
<thead>
<tr>
<th>Grade</th>
<th>Wrapping with or without clipping</th>
<th>Clipping or ligation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3 (4.3%)</td>
<td>4 (2.0%)</td>
</tr>
<tr>
<td>I</td>
<td>14 (20.0%)</td>
<td>50 (25.0%)</td>
</tr>
<tr>
<td>II</td>
<td>31 (44.3%)</td>
<td>76 (38.0%)</td>
</tr>
<tr>
<td>III</td>
<td>11 (15.7%)</td>
<td>40 (20.0%)</td>
</tr>
<tr>
<td>IV</td>
<td>10 (14.3%)</td>
<td>28 (14.0%)</td>
</tr>
<tr>
<td>V</td>
<td>1 (1.4%)</td>
<td>2 (1.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>200</td>
</tr>
</tbody>
</table>

II. Surgical procedures

The lesion and parent artery were wrapped with a small piece of gauze sponge (usually several millimeters in width and length). Gauze sponge is flexible and plastic, so the aneurysm could be wrapped easily and quickly even when surrounded by a large clot. We could also easily preserve cranial nerves running near the aneurysm.

Figure 1 shows the clipping and wrapping of the residual neck of an unruptured vertebral artery-posterior inferior cerebellar artery aneurysm. In this case, we used a single layer of gauze to avoid nerve injury; usually we use double-layer wrapping if possible. No symptoms of lower cranial nerve damage presented after the operation. Figure 2 shows a ruptured semifusiform aneurysm protruding from the dorsal wall of the ICA. A clip was placed parallel to the ICA. There was a residual neck and danger of clip slippage, so we wrapped the neck completely and applied plastic adhesive to fix the gauze securely.

III. Complications

Table 3 shows the incidence and type of complications. Angiospasm was diagnosed by low-density areas on the computed tomographic (CT) scan or clinical symptoms within 2 weeks of surgery. The wrapping and non-wrapping groups presented no significant difference in the incidence of angiospasm. The incidences of postoperative meningitis and of death due to cerebral angiospasm were also not significantly different. However, the non-wrapping group presented a significantly higher incidence of normal pressure hydrocephalus (p < 0.01).

IV. Clinical outcome

Table 4 shows the clinical outcome for 227 patients followed postoperatively from 3 months to 8.5 years (mean, overall 4.1 years, wrapping group 3.5 years). There was no significant difference between the wrapping and non-wrapping groups. In addition, there was no significant difference in the distribution of 142 patients followed for more than 3 years postoperatively: non-wrapping group 116, wrapping group 26, overall mean follow-up period 5.5 years,
Nine patients died after discharge. Three had recurrent subarachnoid hemorrhage (SAH), all in the non-wrapping group. The fatal recurrence occurred more than 5 years postoperatively. The bleeding origins were not known. There was no other recurrent SAH case. The other causes of death were cardiac disease in one, malignant tumor in two, hypertensive intracerebral hematoma in one, and unknown in two.

Six patients had lower GOS score at follow-up than at discharge. This was attributable to orthopedic disease in two, trauma in one, cerebral infarction in two, and unknown cause in one. Both cerebral infarction cases were in the wrapping group, but the lesions were contralateral to the wrapped aneurysm. Therefore, these cerebral infarctions probably had no connection with the wrapping method. No other new lesion (granuloma etc.) was found by the follow-up study and CT scanning.

**Discussion**

Clipping techniques for intracranial aneurysms have advanced considerably. However, regrowth of the aneurysm or recurrent SAH after clipping have been
Fig. 2 Operative photographs and illustrations of a semifusiform aneurysm protruding from the dorsal wall of the internal carotid artery, before (upper) and after (middle) clipping, and after wrapping (lower). Clip is placed parallel to internal carotid artery, but there is a residual neck (arrowhead) and a danger of clip slippage. After wrapping, the residual neck is invested completely and securely fixed with plastic adhesive. AN: aneurysm, C: clip, ICA: internal carotid artery.

Table 3 Incidence of postoperative complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Wrapping with or without clipping</th>
<th>Clipping or ligation</th>
<th>Chi-square test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiospasm</td>
<td>17/78 (21.8%)</td>
<td>65/271 (24.0%)</td>
<td>NS (p &gt; 0.1)</td>
</tr>
<tr>
<td>Normal pressure hydrocephalus</td>
<td>7/70 (10.0%)</td>
<td>38/200 (19.0%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Meningitis</td>
<td>1/70 (1.4%)</td>
<td>3/200 (1.5%)</td>
<td>NS (p &gt; 0.1)</td>
</tr>
<tr>
<td>Death due to spasm</td>
<td>3/70 (4.3%)</td>
<td>10/200 (5.0%)</td>
<td>NS (p &gt; 0.1)</td>
</tr>
</tbody>
</table>

NS: not significant.
Table 4 Clinical outcome (Glasgow Outcome Scale)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Wrapping with or without clipping (n = 56)</th>
<th>Clipping or ligation (n = 171)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>44 (78.6%)</td>
<td>135 (78.9%)</td>
</tr>
<tr>
<td>Moderate disability</td>
<td>5 (8.9%)</td>
<td>23 (13.5%)</td>
</tr>
<tr>
<td>Severe disability</td>
<td>6 (10.7%)</td>
<td>4 (2.3%)</td>
</tr>
<tr>
<td>Vegetative state</td>
<td>0</td>
<td>1 (0.6%)</td>
</tr>
<tr>
<td>Death</td>
<td>1 (1.8%)</td>
<td>8 (4.7%)</td>
</tr>
</tbody>
</table>

reported.5-7,9,10,12,13,19,20) These recurrences were attributable to broken9,12,20) or slipped5) clips, incomplete clipping,6,7,10,13,19) and aneurysmal change of the arterial wall.4,19,21,23>

Complete clipping is the desirable result, but sometimes this is impossible or the aneurysmal neck remains. The residual necks detected on postoperative angiogram ranges from 3.6% to 13.1%.2,5,10,19) The natural history of residual neck and untreated aneurysms is not well understood.1,3,10,15,19,22) Feuerberg et al.10) reported the incidence of rebleeding from residual necks is 0.38-0.79% per year (4-13 years follow-up). Drake and Vanderlinden7) reported rebleeding from residual necks, and Sato and Suzuki19) encountered rebleeding in two of 11 cases with residual neck. Recently, Lin et al.13) reported 19 cases demonstrating regrowth of small residual necks with recurrent SAH in 17 cases during a long follow-up. The incidence of recurrent SAH is low, but it is sometimes fatal. Long-term, periodic postoperative assessment (e.g., angiography) is important. However, the prevention of recurrent SAH cannot be guaranteed. In addition, postoperative angiography causes patient stress and is not free of risk. At present, there is no prophylactic method to prevent recurrent SAH. However, we believe that reinforcement of the residual neck and abnormal arterial wall will lower the incidence of recurrence.

Commonly used reinforcing materials include muscle, human freeze-dried dura, fascia, adhesive plastics, and cotton fiber products.8) Some histological experimental studies have investigated optimal wrapping and coating materials. Sachs17) showed that gauze sponge, wrapped around intracranial blood vessels in dogs, induced a dense fibrotic response after 5 weeks and appeared to provide excellent protection against aneurysm rupture while muscle pieces did not. Ebina et al.8) found that muscle, fascia, dura, and an adhesive plastic (alkyl alpha-cyanoacrylate monomer) were ineffective and unreliable after several months, but a cotton fiber product (Bemsheet®: Bemlyse, Asahikasei Co, Ltd., Nobeoka, Miyazaki) induced an adequately reinforced wall of collagen fibers after 1-2 months of implantation. The cotton fiber remained unchanged and caused almost no inflammatory reaction even after 12 months.

Mount and Antunes41) performed postoperative angiography in three patients with gauze-wrapped or unclipped aneurysm. At follow-up, two aneurysms had disappeared and the other had reduced by 15%. However, negative results have also been reported.24)

Gillingham11) first advocated gauze wrapping of intracranial aneurysms in 1958. Clinical studies followed, but gauze wrapping was performed without prior clipping.14,16,23) At present, clipping is considered as the treatment of choice. We additionally performed gauze wrapping after clipping to prevent bleeding from residual neck or abnormal arterial wall.

In our study, no patient in the wrapping group experienced recurrent hemorrhage. Although there were no autopsies, and no reoperation or follow-up postoperative angiography was performed, we think that the gauze sponge and induced collagen wall prevented aneurysmal regrowth and bleeding. In addition, gauze wrapping may prevent clip slippage. Rebleeding from wrapped aneurysms during long follow-up has been reported, but the location of the bleeding is unclear. We think that it is important to wrap the lesion and the parent artery completely and firmly. The collagen fiber wall induced by cotton fibers was not sufficient to prevent early rebleeding pathologically or clinically.24) In our series, only four patients with ruptured aneurysms underwent wrapping only, so we cannot comment on the risk of recurrence.

The followings may be useful in preventing early and late recurrent SAH: 1) careful assessment of angiographic and operative findings, 2) complete obliteration of the ruptured aneurysm if possible, 3) where obliteration is incomplete or the arterial wall appears abnormal, the lesion and parent artery must be wrapped firmly and completely, 4) gauze wrapping of ruptured aneurysms which cannot be obliterated.

Wrapping may cause more mechanical stimulation of the vessels than clipping alone. We anticipated that an intracranial foreign substance might cause more complications than clipping alone. However, this did not occur in our study. The postoperative complications and outcome in the 2 groups were not significantly different. The results demonstrate that the gauze sponge wrapping method, especially combined with clipping, may prevent recurrent hemorrhage in patients with ruptured intracranial
aneurysm.

References


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