Endovascular surgery has become an alternative treatment for not only surgically unclippable but also acutely ruptured intracranial aneurysms. Among surgeons there is a great deal of interest in the types of occlusive materials used within the lumen of the aneurysm as well as the embolization techniques. Many authors have reported various experimental models of endovascular treatment in which assorted materials are used to occlude aneurysms, including detachable balloons, coils, and liquids. However, because of their shape and relative inflexibility, balloons and coils cannot completely occlude an irregularly shaped aneurysm. We have developed a new liquid material for use in thrombosing an aneurysm, cellulose acetate polymer (CAP) solution, which solidifies and conforms to the contours of irregularly shaped aneurysms without increasing intraaneurysmal pressure. We have applied CAP thrombosis in extravasation in the acute stage of subarachnoid hemorrhage with favorable results. In this article we present our experience using CAP in the endovascular approach to direct thrombosis of lateral canine carotid artery aneurysms. We evaluate the technical aspects of CAP and discuss the angiographic findings and histological changes observed within these aneurysms between 1 week and 1 year after treatment.

Materials and Methods

Aneurysm Creation

Twelve mongrel dogs, weighing 10 to 15 kg each, were used for this study. The dogs were anesthetized with intramuscular injections of ketamine HCl (15 mg/kg) and sodium pentobarbital (25 mg/kg), and then intubated and allowed to breathe room air spontaneously. Further doses of pentobarbital were administered when necessary. The surgical procedures were performed under sterile conditions with the aid of an operating microscope.

Experimental aneurysms were created using a microsurgical technique to produce anastomosed venous pouches in the bilateral common carotid arteries of 12 dogs. The 24 aneurysms were then thrombosed via an endovascular approach with injection of a cellulose acetate polymer (CAP) solution that the authors have developed for use as a liquid thrombotic material. Angiography performed 1 to 4 weeks after CAP injection revealed complete thrombosis of the aneurysm with patency of the parent artery in 16 aneurysms. Histological analysis disclosed that the aneurysmal orifice in these cases was completely covered with newly formed endothelial cells 2 weeks after CAP thrombosis. Three other aneurysms exhibited parent artery occlusion caused by protrusion of the CAP mass through the aneurysmal orifice into the parent artery; this was thought to be caused by over-injection of the CAP solution. Histological analysis of the remaining five aneurysms, initially shown to have incomplete occlusion, revealed that they each possessed a residual neck that was partially covered with endothelial cells. No rupture of the aneurysms or migration of CAP into the distal arteries was observed.

These results suggest that using an endovascular approach, direct thrombosis of cerebral aneurysms with CAP is safe and effective. This technique may prove to be an alternative treatment for such aneurysms. However, there is a potential risk of regrowth or rupture of aneurysms that retain a residual neck and long-term follow-up studies will be required to evaluate this issue.

Key Words • experimental aneurysm • cellulose acetate polymer • endovascular technique • direct thrombosis • histological study • dog
by ligating the free end of the vein segment with No. 3-0 silk thread. The vascular clamps were then removed to allow filling of the venous pouch with blood. These procedures were performed bilaterally, resulting in two aneurysms per dog.

**Liquid Thrombotic Material**

Cellulose acetate polymer solution is a liquid thrombotic material composed of 250 mg CAP, 3 ml dimethyl sulfoxide (DMSO), and 900 mg bismuth trioxide; the latter is used as a contrast medium as reported previously. The CAP is dissolved in DMSO, and the bismuth trioxide powder is added just before use. Cellulose acetate polymer solution is not adhesive and passes easily through a 27-gauge needle. When the material is slowly injected into physiological saline, the DMSO solvent diffuses rapidly into the saline and a CAP mass forms.

**Direct Thrombosis Technique**

The patency of the experimental aneurysms was confirmed by carotid angiography 1 week after creation. Each aneurysm was then thrombosed with CAP using the following method: a No. 7 French double-lumen balloon occlusion catheter or a No. 6 French angiographic catheter was positioned via a transfemoral approach in the CCA as a guiding catheter. A No. 4 French diagnostic catheter was also introduced into the proximal CCA. A Tracker-18 microcatheter was introduced into the dome of the aneurysm through the guiding catheter. Flow control of the parent artery was attained by inflation of the occlusion balloon or by temporary clipping of the proximal CCA (to prevent the CAP from migrating into the distal artery) with the dome of the aneurysm facing downward. A test injection of the contrast medium from the Tracker-18 microcatheter was performed under flow control of the parent artery, and intraaneurysmal stasis of the contrast medium was confirmed. The minimum amount of DMSO required to irrigate the catheter lumen was injected and the CAP solution was slowly administered into the aneurysmal sac, under fluoroscopic control, until complete filling of the aneurysm with the polymer. After the material had solidified (3–5 minutes), the flow control was released and test flushing using contrast medium dispersed through the diagnostic catheter was performed to determine the degree of thrombosis attained with the CAP. If a residual lumen was observed in the aneurysm, additional liquid was injected by the same method. After successful occlusion of the aneurysm was confirmed, the Tracker-18 microcatheter was withdrawn safely with no CAP adhesion to the catheter. Postthrombotic carotid angiograms (Fig. 1A) were compared with postthrombotic plain x-ray films (Fig. 1B) and carotid angiograms (Fig. 1C), which were obtained immediately after occlusion with CAP. Additional angiography was also performed once between 1 and 4 weeks after the occlusion (Fig. 1D), following which the animals were sacrificed and both aneurysms with their parent arteries were removed for histological analysis. This procedure took place with all dogs except one (two aneurysms), which was not sacrificed until 1 year after treatment to allow for the long-term follow-up study.

**Histological Study**

Each resected aneurysm, together with its parent artery, was fixed with formaldehyde. Specimens for histological analysis were sliced in transverse or longitudinal sections, and stained with hematoxylin and eosin for light microscopy. The histological analysis focused on

TABLE 1

<table>
<thead>
<tr>
<th>Follow-Up Period</th>
<th>No. of Specimens</th>
<th>Results</th>
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<tbody>
<tr>
<td>1 week</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>2 weeks</td>
<td>5</td>
<td>4</td>
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<tr>
<td>3 weeks</td>
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<td>4</td>
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<td>3</td>
</tr>
<tr>
<td>1 year</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>16</td>
</tr>
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* CAP = cellulose acetate polymer; good = complete obliteration of the aneurysm with patent parent artery; residual = incomplete obliteration of the aneurysm with patent parent artery; PA occlusion = occlusion of the parent artery.
Thrombosis of experimental aneurysms using CAP

![Figure 3](image_url)

**Fig. 3.** Photographs showing longitudinal sections of resected aneurysms with their parent arteries 1 week after treatment. **Left:** Aneurysm with good angiographic result. The aneurysm is completely thrombosed and the patent parent artery (arrows) is seen. Thrombus totally occupies the free space around the CAP mass, suggesting the high thrombogenicity of CAP. The intraluminal surface of the thrombus is smooth (arrowhead). **Right:** Aneurysm with parent artery occlusion. The CAP mass completely fills the aneurysm and protrudes into the parent artery through the orifice of the aneurysm (arrow). Thrombus is visible in the parent artery (arrowheads).

the orifice of the aneurysm, but the histological reactivity of the entire aneurysm was evaluated. Some specimens were stained with factor VIII-related antigen to examine whether endothelial cells were presented at the aneurysmal orifice.

### Results

#### Angiographic Findings

Twenty-four aneurysms were successfully created in 12 dogs and the patency of these aneurysms was confirmed by carotid artery angiography 1 week later. All of the aneurysms were thrombosed with CAP via an endovascular approach. Angiography performed immediately after CAP injection revealed complete obliteration of the aneurysm with patency of the parent artery in 19 aneurysms. In the remaining five aneurysms, more than 90% occlusion of the volume was observed, but small areas of incomplete obliteration were found adjacent to the aneurysmal neck. Follow-up angiography performed between 1 and 4 weeks after treatment revealed complete obliteration with patency of the parent artery in 16 aneurysms (Table 1). Occlusion of the parent artery was observed in three aneurysms; in all cases the occlusion occurred within 1 week after CAP injection even though patency of the parent vessel had initially been observed. The five aneurysms that initially displayed incomplete occlusion showed no change at follow-up angiography (Fig. 2). One dog in which both aneurysms showed complete obliteration with patency of the parent artery 4 weeks after treatment was selected for a 1-year follow-up study. Angiography 1 year after CAP injection revealed replacement of the thrombus by infiltrated spindle-shaped cells between the CAP mass and the aneurysmal neck. No rupture of the aneurysm or migration of liquid material into the parent vessels was observed following CAP injection in any aneurysm and follow-up plain x-ray films revealed that the size of the CAP mass remained unchanged and that no migration of CAP to the distal arteries occurred in any case. This observation can be verified because the inclusion of bismuth trioxide powder, a strong contrast material, makes it possible to locate even small fragmentation of CAP.

#### Histological Findings

Light microscopic examination was conducted 1 week after treatment in seven aneurysms (including three that had occlusion of the parent artery); 2 weeks after treatment in five, 3 weeks after treatment in six, 4 weeks after treatment in four, and 1 year after treatment in two aneurysms. Light microscopy revealed complete thrombosis of the aneurysm with patency of the parent artery in 16 of the 24 aneurysms. The CAP mass formed a honeycomb-like structure with many black dots of bismuth trioxide visible. One week after treatment, attachment of the thrombus to the irregular surface of the CAP mass was observed at the aneurysmal orifice and the intraluminal surface of the thrombus was relatively smooth. The space between the CAP mass and the aneurysmal wall was also filled with thrombus (that is, the intraneurysmal residual space was totally filled with thrombus) (Fig. 3 left). A few spindle-shaped cells, thought to be immature mesenchymal cells, were seen in the thrombus. Histological examination of the three aneurysms with parent artery occlusion revealed protrusion of the CAP mass through the aneurysmal orifice into the parent artery and existence of thrombus around the CAP (Fig. 3 right).

In examining the aneurysms that had been completely obliterated 2 weeks after injection, we found replacement of the thrombus by infiltrated spindle-shaped cells between the CAP mass and the aneurysmal wall as well as at the aneurysmal orifice. The orifice of the aneurysm was completely occluded by a layer of regenerated endothelial cells on the organized thrombus, which was attached to the surface of the CAP mass (Fig. 4). This cell layer was continuous with the native endothelial cells lining the lumen of the parent artery. Macroscopic examination also revealed endothelium over the aneurysmal orifice (Fig. 5). Three weeks after injection, more apparent replacement of the thrombus by fibrous tissue was observed and the CAP mass within the aneurysm was surrounded by fibrous tissue (Figs. 6 and 7 left). Four weeks after occlusion, a greater degree of organization was observed within the aneurysm.
Histological examination revealed very mild inflammatory cell infiltration of the aneurysm thrombosed with CAP. No adverse effect on the process of aneurysmal healing was observed.

In the five aneurysms with incomplete obliteration of the neck, the space between the CAP mass and the parent arterial lumen was larger than that found in aneurysms without complete thrombosis. The neck was partially covered by endothelial cells, but immature thrombus was attached to some of the residual spaces (Fig. 7 right). Consequently, residual lumen remained at the aneurysmal neck.

The two aneurysms with complete obliteration that we examined 1 year after treatment showed complete separation of the newly developed fibrous tissue from the parent artery. Each aneurysm’s intraluminal surface was covered with a layer of the endothelial cells, which was smoothly continuous with the native endothelial cells of the parent artery (Fig. 8).

Immunohistochemical staining for factor VIII–related antigen revealed faint staining of the endothelial cells 2 weeks after injection and more intense staining at 3 weeks (Fig. 9).

**Discussion**

**Embolization Techniques**

The occlusive materials currently used in the thrombosis of aneurysms are balloons, coils, and liquids. Previous findings indicate that in only a limited number of cases do endovascular balloon techniques successfully occlude only the aneurysm because the balloon configuration is rarely identical to that of the aneurysm.12,28 Balloon occlusion techniques are also associated with a risk of aneurysm rupture.11,24,27 In the endovascular occlusion of aneurysms using coils,8,9,20,22,28 although the risk of aneurysm rupture is lower than that with balloon occlusion, packing of the aneurysm with the coil is difficult when it extends close to the neck of the aneurysm.8,20 Particularly in wide-necked aneurysms, it is quite difficult to occlude the lumen of the aneurysm completely with coils. Guglielmi and colleagues8 reviewed 43 posterior circulation aneurysms treated with the Guglielmi detachable coil; these authors achieved complete aneurysm occlusion in 13 of 16 aneurysms with small necks but in only four of 26 aneurysms with wide necks.

In contrast to these techniques, a liquid material has the potential to conform to the contours of even an irregularly shaped aneurysm without raising intraaneurysmal pres-
However, as seen in our histological study, there may be a significant amount of thrombus associated with CAP and, in fact, we found that thrombus occupied a significant portion of the aneurysm surrounding the CAP mass (Fig. 3 left). Therefore, blood is not entirely excluded from the aneurysm by injection of liquid embolic material. However, CAP fills a greater volume of the aneurysm than coils with less distortion of the wall architecture than that in the aneurysm shown on the left. H & E, original magnification × 8.

The greatest disadvantage of the use of a liquid material for aneurysmal occlusion is thought to be the leakage of the material into the parent artery during injection. Because the CAP solution has moderate viscosity, it passes easily through a Tracker-18 microcatheter yet remains in the aneurysmal lumen under flow control of the parent artery until the aneurysm is completely filled. The CAP appears to solidify in one mass within the aneurysmal sac when it is injected slowly; we did not observe any fragmentation that might cause distal migration. Mandai and coworkers reported that when CAP solution was injected slowly into the canine renal artery with no flow control, the material formed a small cast without reaching the distal portion of the artery and only the main trunk of the artery was occluded. Based on these data, we assume that the possibility of distal migration of CAP is quite small even if the parent artery has some blood flow. Moreover, we have already reported successful CAP thrombosis of anterior communication artery aneurysms without flow control while preserving the parent arteries.

It is necessary to maintain some blood flow into the aneurysm to solidify the polymer, albeit not such a strong flow as to cause the CAP to migrate distally. Thus, in clinical cases, we have used manual Matas’ compression for anterior circulation aneurysms or proximal parent artery occlusion with a microballoon for basilar bifurcation aneurysms. The CAP solution should be injected under a degree of blood flow control that allows most of the contrast material to accumulate at the bottom of the aneurysm.

It should be noted that the injection speed or the direction in which the catheter tip faces inside the aneurysmal

![Fig. 7](image1) ![Fig. 8](image2) ![Fig. 9](image3)
wall might have an influence on the pattern the CAP cast forms. For example, in Fig. 3 left we see a uniform mass of CAP whereas in Fig. 3 right the CAP appears to be lamellated. When 0.5 ml of CAP is injected over a period of 10 seconds into physiological saline, the CAP does not form a mass but rather a long string pattern. When the same amount of CAP is injected more slowly, over a period of 1 to 2 minutes, the CAP solidifies immediately after emerging from the tip of the catheter and forms a mass; thus, we usually inject CAP at this speed. Another advantage of CAP is its ease of application because it does not adhere to the catheter.

In the present study, we selected a lateral carotid artery aneurysm model, which conventionally has been used to test various occlusive materials. It is well known that the small orifice produced in this aneurysm model may cause spontaneous aneurysmal thrombosis, but this will not occur if the ratio of aneurysm volume to orifice area (V/A) is less than 25:1 mm. Based on this principle, we created an aneurysm with a large orifice to avoid spontaneous thrombosis. We subsequently found that thrombosis could be achieved using CAP even in these wide-necked aneurysms.

**Angiographic Follow-Up Study**

Our follow-up angiographic study revealed that complete obliteration of the aneurysm with patency of the parent artery was obtained in 67% of the aneurysms. Graves and colleagues have reported that total obliteration of experimental aneurysms similar to those in our model is difficult with currently available endovascular devices, such as the Guglielmi detachable coil. We attribute the parent artery occlusion observed in our study to overinjection of CAP solution and consequent protrusion of excess CAP through the aneurysmal orifice into the parent artery. After we noted this complication (incidence 13%), we compensated to avoid overinjection of CAP, but as a result five aneurysms (21%) were incompletely occluded. Apparently, it is technically difficult to achieve total occlusion of some wide-necked aneurysms with CAP as with other materials. Use of an inflated microballoon at the aneurysmal orifice as a “protecting” or “rescuing” balloon may be valuable in preventing the migration of CAP into the parent artery during injection. Although Debrun, et al., completely occluded the aneurysmal orifice with an angioplastical balloon during injection of isobutyl-cyanoacrylate (IBCA) into the aneurysmal sac, we suggest that partial rather than total occlusion with a protecting balloon is sufficient to perform CAP thrombosis because what is needed is to temporarily convert a wide-necked aneurysm into a small-necked one. There is always some space between the wall of the parent artery and the catheter used for infusion of CAP and the balloon catheter. This space is necessary so that the DMSO diffuses and the CAP mass forms without raising intraaneurysmal pressure. This technique may be helpful in obtaining complete aneurysmal occlusion with preservation of the parent artery, especially in wide-necked aneurysms. In fact, we have achieved good results using this technique in clinical cases.

Certain techniques are important in obtaining successful aneurysm occlusion with CAP. First, appropriate use of gravity should be followed; because CAP is heavier than blood, it is important that the dome of the aneurysm be correctly oriented during injection. Second, flow control of the parent artery is necessary to prevent the CAP from migrating into the distal artery. Flow control can be attained by inflation of an occlusion balloon or temporary proximal clipping of the parent artery in this experiment. Third, a test injection should be performed after the microcatheter is positioned inside the aneurysm as well as superselective angiography under flow control because it is important to confirm the intraaneurysmal stasis of the contrast medium by observing a fluid–fluid level at the neck and to assess accurately the volume of solution required to obtain complete aneurysm occlusion. Fourth, test flushing should also be performed; CAP can be injected repeatedly if a residual lumen is observed in the aneurysm during test flushing of the contrast medium. During test flushing, it is important to use the radiological angle that provides optimum visualization of the neck. In retrospect, we suspect that the unsatisfactory outcomes of residual neck or parent artery occlusion found in some aneurysms in our study were due to our failure to obtain the optimum fluoroscopic angle. Fifth, the “protecting” balloon technique may prove useful in preventing CAP migration into the parent artery in wide-necked aneurysms.

The optimum outcome of endovascular therapy for cerebral aneurysms is complete and permanent isolation of the aneurysm from the circulation with preservation of the parent artery. Thus, the goal of endovascular therapy is complete aneurysmal thrombosis followed by reendothelialization across the aneurysmal orifice.

Strother and coworkers reported a case of fatal rupture of a large paraophthalmic aneurysm 11 months after treatment with detachable balloons. Their microscopic examination of the ruptured aneurysm revealed that most of the aneurysmal lumen not occupied by balloons was filled with old and recent thrombus. This means that the aneurysm had not been isolated from the circulation by the balloons and that reendothelialization had not occurred. Some experimental data have shown reendothelialization over the aneurysmal orifice after endovascular occlusion using balloons, coils, and liquid materials. Miyachi and colleagues examined the causes of aneurysm rupture after incomplete treatment with balloon embolization and found that the aneurysmal orifice frequently exhibited delayed endothelialization after thrombus organization compared with that shown in spontaneous obstruction or fibrin sealant injection. In their balloon embolization models, these authors also found that endothelialization at the orifice in aneurysms treated with silicone balloons was delayed compared to that found in aneurysms treated with latex balloons because the former is an antithrombogenic material. These authors suggest that the antithrombogenic property of these balloons might decelerate the organizing process and that lack of adhesion of clots to the balloon surface might delay endothelialization. Heilman, et al., have also reported aneurysmal recurrence after endovascular balloon occlusion in a rabbit bifurcation aneurysm model. Nine of 10 balloon-treated aneurysms recurred although initial examination had shown their complete obliteration. These authors’ histological study revealed no marked intimal
membrane at the aneurysmal orifice. From their findings we can infer the importance of initial complete occlusion of the aneurysm and early development of reendothelialization over the aneurysmal orifice. It is presumed that use of occlusive materials with highly thrombogenic property leads to early organization with endothelial cell proliferation.

**Histological Study**

Although in our study angiography disclosed complete aneurysmal occlusion after CAP thrombosis, microscopy revealed very small cavities between the CAP mass and the parent arterial lumen, residual space, or the aneurysmal wall. The residual spaces within the aneurysm were filled with thrombus in most aneurysms. The evaluation of serial histological data from the aneurysm revealed that, along with its attachment to the irregular surface of the CAP mass at the aneurysmal orifice, the thrombus also filled the residual space between these two structures. The intraluminal surface of the thrombus was smoothly continuous with the parent arterial wall and spindle-shaped cells, thought to be immature mesenchymal cells, proliferated throughout the thrombus. After a slow progressive organization of thrombus around the CAP mass and reendothelialization over the aneurysmal orifice, the aneurysm was totally excluded from the circulation. The intraneurysmal free space around the CAP mass was filled with fibrous tissue 3 to 4 weeks after treatment. Although crescent-shaped aneurysmal remnants, indicating growth and rupture, have often been observed in aneurysms thrombosed with balloons or coils, they were rarely seen in the aneurysms thrombosed with CAP and a layer of new endothelial cells formed over the orifice and continued smoothly to the parent arterial wall. We presume that the high thrombogenicity of CAP contributed to the good organization and early endothelialization.

The immunohistochemical results for staining for factor VIII–related antigen indicate that endothelial cells developed within 2 weeks after thrombosis. We speculate that the difference in the degree of staining observed at 2 and 3 weeks was due to the immaturity of the endothelial cells at 2 weeks. We believe that complete reendothelialization over the orifice was present 2 weeks after injection. This period is shorter than that described in reports of thrombosis obtained with balloons or coils. It is believed that spontaneous intraneurysmal thrombolysis may occur even when initial complete aneurysmal thrombosis is obtained with balloons and that this phenomenon may cause recanalization resulting in regrowth or rupture of the aneurysm. We consider that early reendothelialization over the aneurysmal orifice can prevent recanalization of the aneurysm. In this regard, CAP is superior to other occlusive materials. In studies using liquid thrombotic materials, reendothelialization often has been observed to develop earlier than when other materials are used. Debrun, et al., reported that epithelial cells covered the neck of canine experimental aneurysms filled with IBCA 1 month after treatment. Moriglione, et al., also found in a rabbit model a layer of endothelial cells bridging the orifice of an aneurysm 14 days after treatment with fibrin sealant. However, these authors injected the liquid material into the dome of the aneurysm by direct puncture, which is not appropriate in aneurysm patients.

In our study, of the five aneurysms with incomplete obliteration, none showed spontaneous obliteration via progressive thrombosis up to 4 weeks later, even though initial angiography had revealed occlusion of more than 90% of their volume with CAP. Histological study of these aneurysms revealed incomplete endothelialization over the aneurysmal orifice and a residual neck was partially occupied by immature thrombus. Graves and coworkers studied flow dynamics in a lateral carotid artery aneurysm model after endovascular treatment with balloons or coils. They concluded that filling the aneurysm and blocking or displacing the inflow zone (that is, the distal aspect of the aneurysm orifice) can produce thrombosis of an aneurysm with preservation of the parent artery. Our histological analysis revealed the presence of residual lumen near the inflow zone of the aneurysm. It is assumed that turbulent flow, which is generated in the residual neck, interrupts formation and attachment of the thrombus at the residual neck. Therefore, the aneurysmal orifice remains open, and endothelialization over the orifice does not occur. Although we observed no rupture of aneurysms following endovascular treatment with CAP, aneurysms with residual neck are likely to rupture, even if the distal aspect of the aneurysm orifice is partially occupied by a thrombus. In the present study, the total follow-up period for aneurysms with residual neck was short (4 weeks). Serial angiographic study is required to observe the fate of such aneurysms.

**Summary**

Graves and coworkers recently reported the results of coil compaction after aneurysmal thrombosis with platinum fiber coils or Guglielmi detachable coils. The coil compaction caused incomplete aneurysm thrombosis, even in some aneurysms in which complete occlusion had initially been attained. In our study, the size of the CAP mass remained unchanged for up to 1 year. In fact, no recurrence was observed in any aneurysms in which complete obliteration was initially obtained.

As pointed out by Chaloupka and colleagues, the application of CAP is complicated by the use of concentrated DMSO. We did not observe the angiographic vasospasm that they have described and the parent artery distal to the aneurysm showed no histological damage. Moreover, our previous histological examination of canine renal arteries thrombosed with CAP revealed no marked vascular inflammatory reaction during either the acute phase or the long-term follow-up period (unpublished data). From these results we conclude that the minimum amount of DMSO that we used has no toxic effect on cerebral arteries.

Our long-term follow-up examination 1 year after CAP injection revealed complete exclusion of the aneurysm from the circulation, due to the presence of CAP with surrounding fibrous tissue, and no inflammatory cells in the parent artery. These findings indicate the long-term safety and efficacy of this procedure in the treatment of aneurysms.

In this study of 24 canine wide-necked aneurysms thrombosed with CAP via endovascular approach, no rupture was observed during the observation period. Angiographic and histological examination confirmed that complete thrombosis of the aneurysm with the patent parent
artery was achieved in 16 of the aneurysms. In these cases complete reendothelialization over the aneurysmal orifice was observed 2 weeks after CAP injection, a shorter period than that reported in thrombosis with other occlusive materials. Long-term (1-year) follow-up data indicate that CAP thrombosis is safe and effective. Further long-term follow-up study is required in cases of aneurysms with incomplete obliteration at the neck.

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References