Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Editor-in-Chief: **James I. Ausman**, MD, PhD University of California, Los Angeles, CA, USA

Original Article

Usefulness of embolization of the middle meningeal artery for refractory chronic subdural hematomas

Takao Hashimoto, Tomoo Ohashi[1], Daisuke Watanabe, Syunichi Koyama[2], Hiroaki Namatame, Hitoshi Izawa, Rei Haraoka, Hirofumi Okada, Norio Ichimasu, Jiro Akimoto, Jo Haraoka

Departments of Neurosurgery, [2]Geriatry, Tokyo Medical University, 6-7-1 Nishishinjyuku Shinjyukuku Tokyo 160-0023, [1]Neurosurgery, Tokyo Medical University, Ibaraki Medical Center, 3-20-1 Cyuou, Amimachi Inashikigun, Ibaraki 300-0395, Japan

E-mail: *Takao Hashimoto - thashimoto-nsu@umin.ac.jp; Tomoo Ohashi - tooohashi-nsu@umin.net; Daisuke Watanabe - d.watanabe1978@gmail.com; Syunichi Koyama - sk0822_1973@yahoo.co.jp; Hiroaki Namatame - namatame-nsu@umin.ac.jp; Hitoshi Izawa - hizawa.izawa@gmail.com; Rei Haraoka - r9e0i6@yahoo.co.jp; Hirofumi Okada - halloweenboy1980@yahoo.co.jp; Norio Ichimasu - nori33math@gmail.com; Jiro Akimoto - akimoto-nsu@umin.ac.jp; Jo Haraoka - n-surg@tokyo med.ac.jp
*Corresponding author

Received: 18 January 13 Accepted: 10 July 13 Published: 19 August 13

This article may be cited as:
Hashimoto T, Ohashi T, Watanabe D, Koyama S, Namatame H, Izawa H, *et al*. Usefulness of embolization of the middle meningeal artery for refractory chronic subdural hematomas. Surg Neurol Int 2013;4:104.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2013/4/1/104/116679

Abstract

Background: Chronic subdural hematoma (CSDH) is generally treated by burr hole irrigation. However, sometimes repeated recurrence is observed, and treatment may consequently become difficult. We examined the efficacy of embolization of the middle meningeal artery (MMA) for such cases.

Methods: We considered embolization of the MMA for three patients who had refractory CSDH with repeated recurrence and two CSDH patients who were at risk of recurrence and showed signs of recurrence after surgery. A microcatheter was advanced through the MMA as peripherally as possible, and embolization was performed with 15-20% *n*-butyl-2-cyanoacrylate or 200 μm polyvinyl alcohol particles.

Results: Embolization was performed in the three patients who had refractory CSDH with repeated recurrence: The procedure was performed after burr hole irrigation of the hematoma in two patients and before the irrigation in one patient. In the two CSDH patients at risk of recurrence, embolization was performed when signs of recurrence appeared. The timing of embolization differed for each patient. However, in all the patients, the hematoma tended to decrease in size, and no recurrence was observed.

Conclusion: Embolization of the MMA is effective for refractory CSDH or CSDH patients with a risk of recurrence, and is considered an effective therapeutic method to stop hematoma enlargement and promote resolution.

Key Words: Chronic subdural hematoma, embolization, middle meningeal artery, recurrence

Access this article online
Website: www.surgicalneurologyint.com
DOI: 10.4103/2152-7806.116679
Quick Response Code:

INTRODUCTION

Chronic subdural hematoma (CSDH) is generally treated by burr hole irrigation. Postoperative recurrence is observed in approximately 10% of all the cases.[6,8,12] In elderly patients with severe cerebral atrophy or those receiving oral antiplatelet/anticoagulant drugs, repeated recurrence is sometimes observed, and treatment may

consequently become difficult. We embolized the middle meningeal arteries (MMA) in patients who had refractory CSDH with repeated recurrence and favorable outcomes were obtained. The efficacy of the method has been reported here.

MATERIALS AND METHODS

This study included five patients treated at our hospital and its affiliated institutions between January 2008 and December 2011. Embolization using *n*-butyl-2-cyanoacrylate (NBCA) or polyvinyl alcohol (PVA) particles was approved by the Tokyo Medical University institutional review board, and all patients provided written informed consent before treatment.

Embolization of the MMA was considered for patients who had refractory CSDH with repeated recurrence or CSDH patients who were at risk of recurrence and showed signs of recurrence after surgery.

Under local anesthesia, a 6F guiding catheter was inserted into the external carotid artery on the lesion side. A microcatheter was advanced through the MMA as peripherally as possible, and embolization was performed with 15-20% NBCA or 200 μm PVA particles. In principle, both the frontal and parietal branches of the MMA were embolized with NBCA. However, PVA was concomitantly used when there were many sites for embolization.

RESULTS

Table 1 shows the characteristics of each of the five patients included in this study. Three of the patients had refractory CSDH with repeated recurrence and two patients were at risk of recurrence and were treated when signs of recurrence appeared. Embolization was performed in the three patients with refractory CSDH; the procedure was performed embolization after burr hole irrigation of the hematoma in two patients and immediately before irrigation in one patient.

In all patients, the follow-up courses were favorable without recurrence.

Representative cases

Case 1

The patient was a 79-year-old male who had been receiving chemotherapy since he was diagnosed with peritoneal mesothelioma. He visited a neighborhood hospital when he experienced a fall and received a hard blow to the back of the head. One month later, his follow-up head computed tomography (CT) showed a thin right-sided CSDH, and he was prescribed oral administration of ibudilast and was followed up. Because hematoma enlargement was observed 4 months later [Figure 1a], right-sided burr hole irrigation was performed [Figure 1b]. However, mild left hemiparesis occurred 3 months later. Head CT performed subsequently showed recurrence. Burr hole irrigation was repeated, resulting in the resolution of the left hemiparesis. Because of further recurrence in the following month [Figure 1c], a third burr hole irrigation was performed [Figure 1d]. Subsequently, embolization of the MMA was scheduled.

Embolization

Embolization of the MMA was performed 6 days after the third burr hole irrigation of the hematoma.

A 6F guiding catheter was inserted from the left femoral artery and placed in the right external carotid artery. A microcatheter was advanced into the parietal branch of the right MMA. Subsequently, angiography was performed, which showed cotton wool-like staining [Figure 2]. Sixteen per cent NBCA was injected after confirmation of the negative result of a provocative test with 1% lidocaine injection. The frontal branch was also embolized with 16% NBCA in a similar procedure.

Postoperative course

The right subdural space was observed to gradually decrease in size. There was no sign of recurrence during the first month after embolization [Figure 3a]. Although some traces were seen on head CT images taken 3 months later, the hematoma had almost disappeared [Figure 3b].

No recurrence has been observed since then.

Table 1: Summary of cases

Age/gender	Side	Background	Timing of embolization	Embolic material	Recurrence
79/M (case 1)	Rt	Elderly patient Brain atrophy Mesothelioma	After the 3rd irrigation	16% NBCA	-
55/M	Lt	Heavy drinker	After the 2nd irrigation	20% NBCA	-
87/M	Lt	Elderly patient Brain atrophy	Before the 3rd irrigation	16% NBCA	-
73/F	Bil	Elderly patient Brain atrophy	On signs of recurrence	18% NBCA 200 μm PVA	-
63/F (case 2)	Lt	Anticoagulant use	On signs of recurrence	16% NBCA	-

NBCA: *n*-butyl-2-cyanoacrylate, PVA: Polyvinyl alcohol

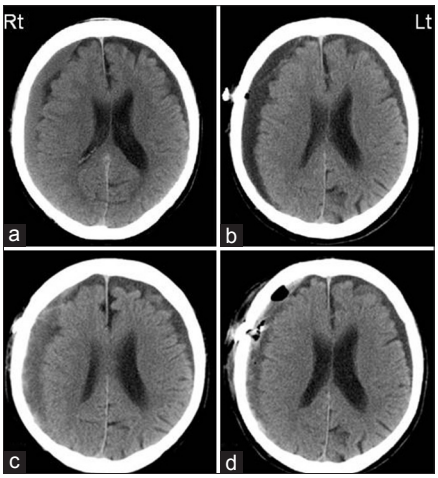

Figure 1: (a) CT scan on admission showing the right CSDH. (b) CT scan after the first irrigation. (c) CT scan 1 month after the second irrigation, showing re-recurrence of right CSDH. (d) CT scan after the third irrigation

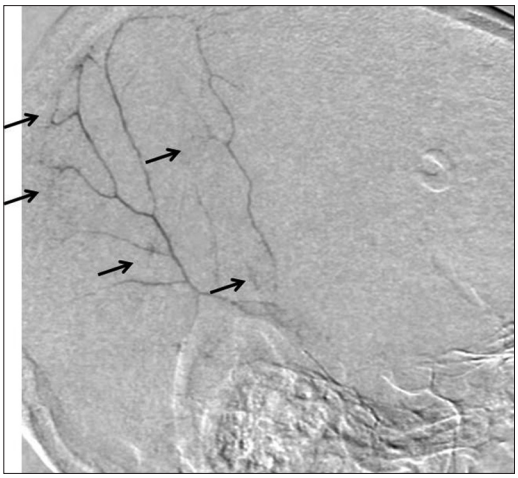

Figure 2: Superselective angiography of the right MMA. Abnormal vascular networks are seen (arrows)

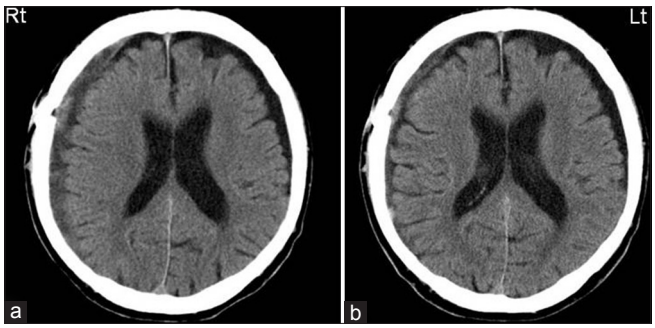

Figure 3: (a) CT scan 1 month and (b) 3 months after embolization of the MMA showed a decrease in the size of the right CSDH

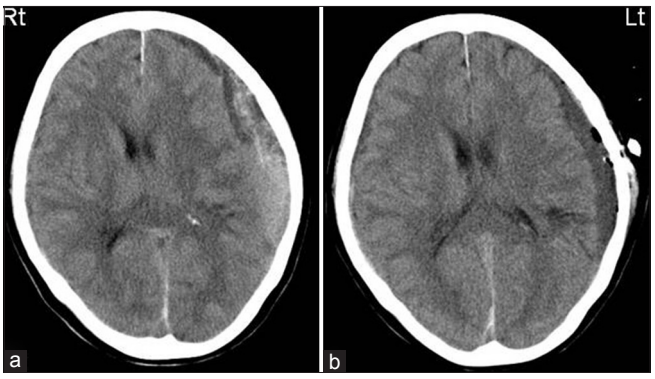

Figure 4: (a) Initial CT scan showing left CSDH and (b) CT scan after irrigation

Case 2

The patient was a 68-year-old female who had been treated for cerebral infarction and pulmonary embolism with oral warfarin. She had no history of head bruises. She visited our hospital with a chief complaint of disorientation. Head CT showed left-sided CSDH [Figure 4a], and left-sided burr hole irrigation of the hematoma was performed [Figure 4b]. Because of the high risks associated with discontinuation of warfarin, she was followed up with continuation of the oral administration. Although CT performed 1 month later showed only slight changes of density [Figure 5a], head CT performed 2 months later showed a slight enlargement of the hematoma and increased density [Figure 5b]. These findings were considered as signs of recurrence, and embolization of the middle MMA was performed.

Embolization

A 6F guiding catheter was inserted from the right femoral artery and placed in the left external carotid artery. A microcatheter was advanced into the left MMA. Subsequently, angiography was performed, which showed cotton wool-like staining [Figure 6]. The microcatheter was further advanced to the frontal branch. Twenty per cent NBCA was injected after confirmation of the negative result of a provocative test with 1% lidocaine injection. The parietal branch was also embolized with 20% NBCA in a similar procedure.

Postoperative course

The hematoma started to decrease in size 1 week after embolization [Figure 7a] and disappeared in 4 months [Figure 7b].

No recurrence has been observed since then.

DISCUSSION

In general, CSDH is treated with 1 or 2 burr hole irrigation, which helps achieve resolution in many cases. However, in elderly patients, patients with cerebral atrophy, patients with blood coagulation disorders, and patients receiving oral antiplatelet/anticoagulant drugs, resolution may not be achieved even after several rounds of surgery, and CSDH is sometimes difficult to treat.

The risk factors for recurrence after burr hole irrigation for CSDH include the following: (1) chronic alcoholism, (2) old age, (3) cerebral atrophy, (4) hepatic dysfunction,

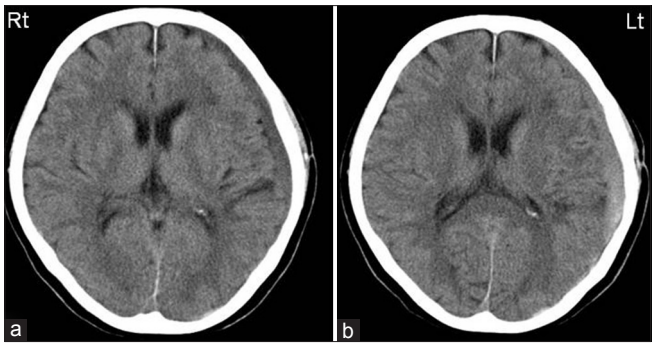

Figure 5: (a) CT scan 1 month after irrigation demonstrated slight density change and (b) 2 months after irrigation, the left CSDH slightly increased in size and its density increased greatly

Figure 6: Superselective angiography of the left MMA. Abnormal vascular networks are seen (arrow)

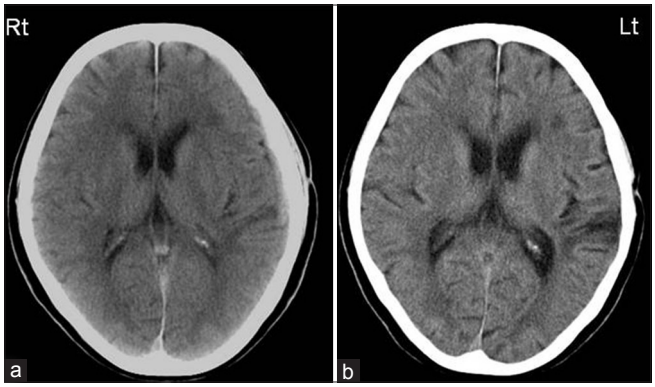

Figure 7: (a) CT scan 1 week after embolization of the MMA showed a decrease in the size of the left CSDH and (b) 4 months after embolization, the left CSDH disappeared.

(5) use of oral anticoagulant drugs, (6) hemodialysis, (7) blood coagulation disorder, (8) subdural fluid collection in pediatric patients, (9) conditions after cerebrospinal fluid shunt, (10) time from onset to treatment, (11) no placement of any drain during surgery, and (12) postoperative residual air.[1,7]

Generally, in cases of CSDH, head trauma causes rupture of the bridging vein, which connects the brain and the dura mater. Under the dura mater, blood from the ruptured vein and the spinal fluid in the brain area mix together, resulting in accumulation of bloody fluid, which gradually coats the cavity and causes hematoma formation. Histopathological findings show that the membranes of the hematoma cavity have a 2- to 3-layered structure. In the outer layer, formation of giant capillaries and infiltration with macrophages are seen; in the inner layer, small neovessels and inflammatory cells such as macrophages and polymorphonuclear leukocytes are observed. The mechanism of the enlargement of the hematoma cavity is considered to be intermittent bleeding to the hematoma cavity due to the rupture of these neovessels.[5] Tanaka *et al*.[10] performed a histological study of vascular structure between the dura mater and the outer membrane in CSDH. A lot of communicating vessels are present, these are classified in capillary-like vessels, small vein, and small arteries. These vessels penetrate through the dura mater and connect to the MMA. This also suggests that embolization of the MMA can intercept the blood supply to the outer membrane and stop hematoma enlargement.

The angiographic findings showed cotton wool-like staining of the peripheral end of the MMA, which is speculated to be a giant capillary of the outer membrane of the hematoma. Such a finding becomes apparent especially when super selective angiography of the MMA is performed. This finding may be apparent in the case of a highly active CSDH where recurrence is observed.

There are few case reports and very small case series reported.[2-4,9,11] Embolization of the MMA is highly useful for refractory CSDH by these reports. The commonly used embolic materials are NBCA, PVA, and coils, which all show the same therapeutic outcomes. However, we consider that selecting embolic materials to allow embolization at more peripheral locations increases the therapeutic effects. From this perspective, it may be better to use NBCA, a liquid embolic material, at a low concentration. However, caution should be exercised to prevent aberrant flow into the ophthalmic artery, the anastomosis with the internal carotid artery through the inferolateral trunk, or the feeding vessel to the facial nerve. If we found anastomosis of MMA and ophthalmic artery, we consider embolization of proximal MMA with coils. It is important to insert a microcatheter as peripherally as possible to perform the procedure safely. We usually perform provocative test with lidocaine for prevention of these neurological deficits.

In this study, although embolization was performed at a different timing in each patient, favorable outcomes were obtained regardless of the timing. In previous studies, the timing of treatment also differed among individual patients. Although an increase in the number of cases and further studies are necessary, embolization of the MMA can be considered to be highly effective for refractory

CSDH. Moreover, in patients with a risk of recurrence, such as elderly patients with severe cerebral atrophy or those requiring treatment with oral antiplatelet/anticoagulant drugs, it also seems favorable to perform therapeutic interventions at an early stage when signs of recurrence are observed.

CONCLUSION

Embolization of the MMA was effective for refractory CSDH with repeated recurrence. Moreover, in CSDH patients at risk of recurrence, favorable outcomes were obtained by performing embolization at an early stage when signs of recurrence appeared. Embolization of the MMA is a highly effective therapeutic method to stop hematoma enlargement and to promote resolution.

REFERENCES

1. Arbit E, Patterson RH Jr, Fraser RA. An implantable subdural drain for treatment of chronic subdural hematoma. Surg Neurol 1981;15:175-7.
2. Ishihara H, Ishihara S, Kohyama S, Yamane F, Ogawa M, Sato A, *et al.* Experience in endovascular treatment of recurrent chronic subdural hematoma. Interv Neuroradiol 2007;13:141-4.
3. Mandai S, Sakurai M, Matsumoto Y. Middle meningeal artery embolization for refractory chronic subdural hematoma: Case report. J Neurosurg 2000;93:686-8.
4. Mino M, Nishimura S, Hori E, Kohama M, Yonezawa S, Midorikawa H, *et al.* Efficacy of middle meningeal artery embolization in the treatment of refractory chronic subdural hematoma. Surg Neurol Int 2010;1:78.
5. Nagahori T, Nishijima T, Takaku A. Histological study of the outer membrane of chronic subdural hematoma: Possible mechanism for expansion of hematoma cavity. No Shinkei Geka 1993;21:697-701.
6. Robinson RG. Chronic subdural hematoma: Surgical management in 133 patients. J Neurosurg 1984;61:263-8.
7. Shiomi N, Sasajima H, Mineura K. Relationship of postoperative residual air and recurrence in chronic subdural hematoma. No Shinkei Geka 2001;29:39-44.
8. Suzuki K, Sugita K, Akai T, Takahata T, Sonobe M, Takahashi S. Treatment of chronic subdural hematoma by closed-system drainage without irrigation. Surg Neurol 1998;50:231-4.
9. Takahashi K, Muraoka K, Sugiura T, Maeda Y, Mandai S, Gohda Y, *et al.* Middle Meningeal artery embolization for refractory chronic subdural hematoma: 3 case reports. No Shinkei Geka 2002;30:535-9.
10. Tanaka T, Kaimori M. Histological study of vascular structure between the dura mater and the outer membrane in chronic subdural hematoma in an adult. No Shinkei Geka 1999;27:431-6.
11. Tsukamoto Y, Oishi M, Shinbo J, Fujii Y. Transarterial embolization for refractory bilateral chronic subdural hematomas in a case with dentatorubral-pallidoluysian atrophy. Acta Neurochir 2011;153:1145-7.
12. Tsutsumi K, Maeda K, Iijima A, Usui M, Okada Y, Kirino T. The relationship of preoperative magnetic resonance imaging findings and closed system drainage in the recurrence of chronic subdural hematoma. J Neurosurg 1997;87:870-5.

Disclaimer: The authors of this article have no conflicts of interest to disclose, and have adhered to *SNI's* policies regarding human/animal rights, and informed consent. Advertisers in *SNI* did not ask for, nor did they receive access to this article prior to publication.