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TECHNICAL NOTE

Clipping on sling-wrap method using a polyglycolic acid sheet in a thin-walled or atherosclerotic middle cerebral artery aneurysm: technique note

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Abstract

During surgical treatment of cerebral aneurysm, thin-walled or severe atherosclerotic aneurysms on the middle cerebral artery are sometimes observed. Owing to the vulnerability or stiffness of the aneurysm, simple neck clipping is usually difficult. We aimed to describe a sling-wrap clipping method using a polyglycolic acid (PGA) sheet for thin-walled or atherosclerotic middle cerebral artery aneurysms. The sling-wrap clipping method was performed in six patients with middle cerebral artery aneurysms. After the distal Sylvian approach, the aneurysm and parent artery were slung up like a baby sling by using a transparent PGA sheet. The aneurysm was directly clipped with the PGA sheet by grasping both ends of the sheet and holding them up. Contrary to the existing wrapping methods, our method could directly obstruct the aneurysm under good visibility through the sheet, thereby avoiding slipping in/out of the clip blade. All cases of the sling-wrap clipping method performed in this study were successful. No problems related to this method were encountered. Aneurysm recurrence, allergic reaction to the PGA sheet, and parent artery stenosis were not observed during the follow-up period. The sling-wrap clipping method using a PGA sheet is safe and another surgical option for thin-walled or atherosclerotic middle cerebral artery aneurysms.

Keywords Atherosclerosis · Sling-wrap clipping method · Middle cerebral artery · Polyglycolic acid sheet · Surgical treatment · Thin-walled aneurysm

Introduction

On pathological examination, blood blister-like aneurysms appear as focal arterial wall lacerations covered with thin fibrous tissue and adventitia that lack the usual collagen layer suggestive of a pseudoaneurysm [14, 24, 25, 30]. The wrap-clipping method has been established as a treatment option for this aneurysm and can provide reinforcement in holding the applied clip to prevent rupture and enlargement [2, 6, 11]. In this method, various wrapping materials have been used, including muscle fascia [11], muslin [2], Gore-Tex [2], Silastic sheet [11, 17, 19], and collagen-impregnated Dacron fabric [29]. On the other hand, the present authors have occasionally observed a thin-walled or atherosclerotic aneurysm on the bifurcation of the parent artery during surgical treatment of cerebral aneurysms. In these aneurysms, tearing of the aneurysm neck or slipping in/out of the clip will be able to cause serious complications. For the first time, a clipping on sling-wrap method in which a polyglycolic acid (PGA) sheet is described herein in patients with a thin-walled or atherosclerotic middle cerebral artery (MCA) aneurysms.

Methods

Between September 2013 and April 2018, 770 patients with intracranial aneurysm were endovascularly ($n = 451$) or surgically treated ($n = 319$) at our institution. In the 319 patients who received surgical treatment, the present authors used the sling-wrap clipping method with a PGA sheet in six patients. This technical note was approved by the institutional ethics committee of Hyogo College of Medicine.

The PGA sheet used was Neoveil (Gunze, Kyoto, Japan) and has been used as an artificial fiber cloth reinforcement for missing organs [13, 35].

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Surgical technique

A frontotemporal craniotomy preserving the ipsilateral superficial temporal artery was performed under general anesthesia. After meticulous dissection between the aneurysm and the surrounding structure via the distal transsylvian approach, a thin-walled or atherosclerotic aneurysm was exposed on the bifurcation of the MCA (Fig. 1, left). The M1 segment of the MCA was secured for proximal control. Whether lateral lenticulostriate arteries and the small branch separate from the bottom of the M2 segment of the MCA was meticulously observed. The aneurysm and M2 were slung up like a baby sling by using a PGA sheet trimmed to the proper size with scissors (Fig. 1, center). This sling increases the surface area and prevents clip slippage. Both ends of the PGA sheet were grasped and held up by forceps, and the aneurysm was directly clipped together with the PGA sheet (Fig. 1, right). Owing to the transparent PGA sheet, surgeons could perform clipping under direct visual guidance.

Outcome

The outcome was evaluated at the 30-day, 6-month, and 12-month follow-up examination or the last hospital visit with the use of a modified Rankin Scale [38], either by telephone interviews with the patient or family members or during a physical examination in those who visited our hospital.

Postoperative computed tomography (CT) and magnetic resonance imaging (MRI) were performed within 1 week after the surgery to evaluate hemorrhagic and ischemic intracranial lesions. The patients undertook CT angiography 1 week after the surgery to confirm the patency of the MCA and the disappearance of flow into the aneurysm. The patients underwent additional MRI imaging/angiography every 1–3 months, between 3 and 6 months, and every 6–12 months beyond 12 months after the surgery.

Results

The clinical and radiological characteristics of the subjects are summarized in Table 1. The median age was 72 years (interquartile range (IQR), 65–75 years), and four patients were male. Five of six patients had unruptured aneurysms. The median size of the aneurysm was 5.8 mm (IQR, 5.5–7.1 mm). All the patients had a thin-walled or severe atherosclerotic aneurysm on the MCA bifurcation. Sling-wrap clipping methods were successful in all the patients. No problems related to this method were encountered in this study. Aneurysm recurrence, allergic reaction to the PGA sheet, and parent artery stenosis were not observed during the follow-up period (median, 320 days; IQR, 216–418 days).

An illustrative case (case 6)

An 82-year-old woman was referred to our hospital to receive treatment for subarachnoid hemorrhage. CT and MRI findings indicated a subarachnoid hematoma in the left Sylvian fissure (Fig. 2a, b). Digital subtraction angiography revealed a dolichoectatic change of the left anterior and middle cerebral arteries, which indicated a tiny bleb on the bifurcation of the left MCA (Fig. 2c, d). After the left frontotemporal craniotomy and distal Sylvian approach, a thin-walled and atherosclerotic aneurysm on the MCA bifurcation was observed (Fig. 3a). No lateral lenticulostriate arteries and small artery were found on the bottom of the M2 segment. The aneurysm and M2 segment were slung up by a transparent PGA sheet (Fig. 3b), and the aneurysm was clipped together with the PGA sheet (Fig. 3c). Indocyanine green videoangiography and Doppler echo confirmed the patency of the parent arteries and the disappearance of flow into the aneurysm (Fig. 3d).

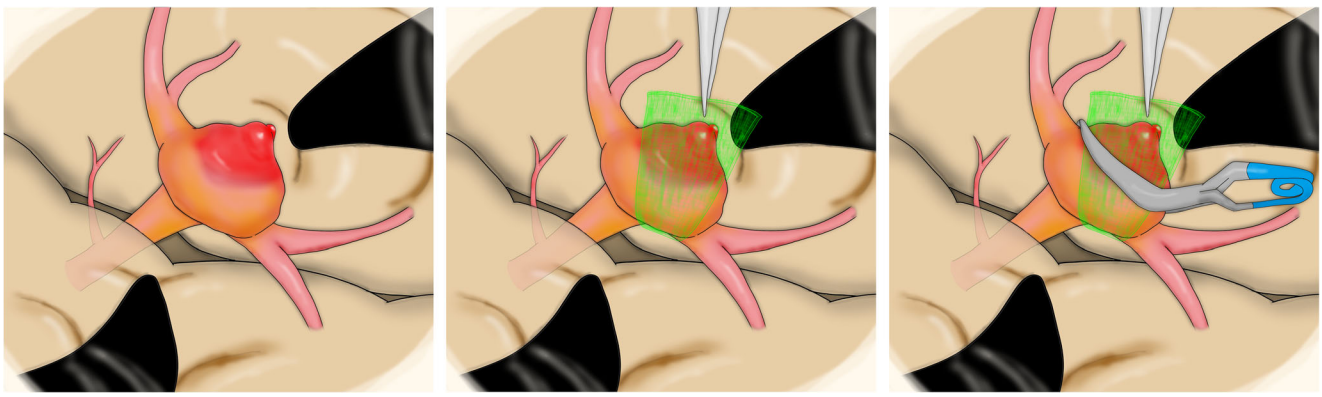

Fig. 1 Illustrations demonstrate the sling-wrap clipping method using a PGA sheet. Left: A thin-walled atherosclerotic aneurysm was observed on the MCA bifurcation. Center: The aneurysm and M2 segment of MCA were slung up by microforceps using the PGA sheet. Right: The aneurysm was directly clipped together with the PGA sheet

Table 1 Summary of sling-wrap clipping method in six patients

Case	Age (years), sex	rupture	Aneurysm size (mm)	Reason of sling-wrap clipping	Ischemic complication	FUP (M)	Recurrence	mRS		
								Pre	30 days	6 M
1	72, male	–	8.3	Severe atherosclerosis of MCA	None	18	–	0	0	0
2	71, male	–	5.8	Severe atherosclerosis of MCA and thin aneurysm dome	None	9	–	0	1	0
3	48, female	–	5.9	Severe atherosclerosis of MCA and thin aneurysm dome	None	8	–	1	1	1
4	70, female	–	5.2	Severe atherosclerosis of MCA	None	12	–	0	0	0
5	73, female	–	5.8	Severe atherosclerosis of MCA	None	11	–	0	0	0
6	82, female	+	NA	Severe atherosclerosis of MCA and thin aneurysm dome	None	4	–	3	2	NA

FUP, follow-up period; *M*, month; *MCA*, middle cerebral artery; *mRS*, modified Rankin Scale; *NA*, not applicable

Postoperative MRI revealed no surgery-related ischemic complications, and CT angiography revealed no worsening of MCA stenosis. She was discharged to a rehabilitation hospital 3 weeks after the surgery (modified Rankin Scale score, 2).

Discussion

As a cerebral aneurysm develops, destructive remodeling is thought to occur through spatial disorganization of the endothelium and thinning of the internal elastic lamina and tunica

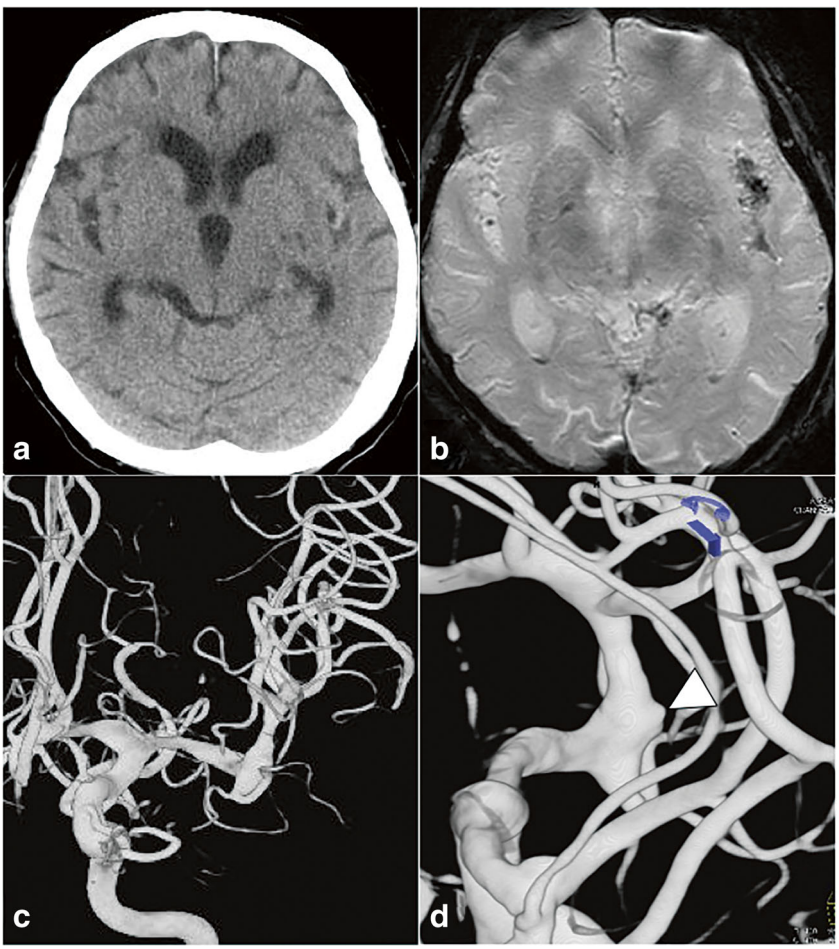

Fig. 2 Axial CT and T2* MR image show iso-density and low-intensity lesions on the left Sylvian fissure (**a**, **b**). Digital subtraction angiography shows dolichoectatic changes of left anterior and middle cerebral arteries (**c**) and a tiny bleb on the left MCA bifurcation (**d**)

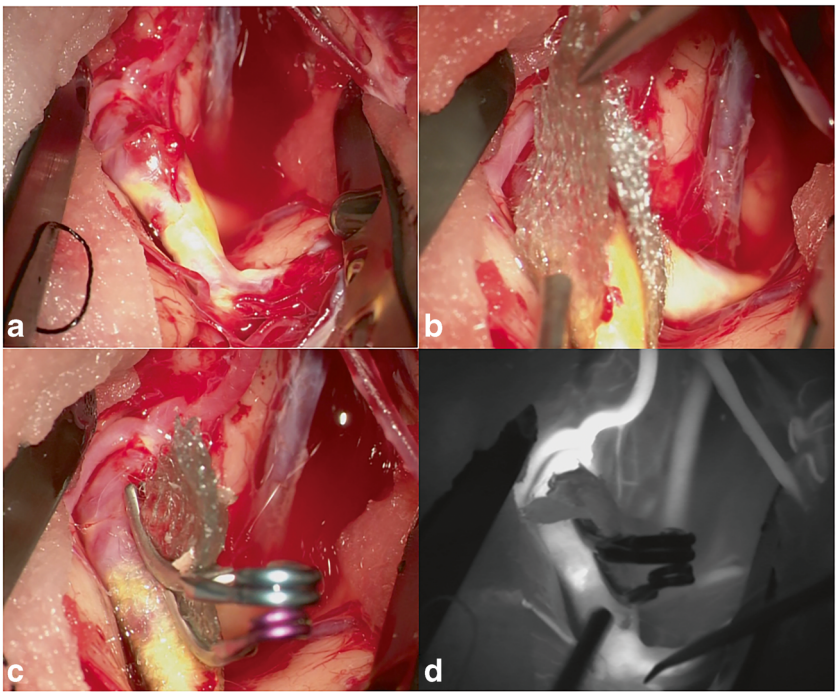

Fig. 3 Intraoperative photograph shows a thin-walled atherosclerotic aneurysm on the MCA bifurcation (**a**). Aneurysm and M2 segment were slung up by a PGA sheet with microforceps (**b**) and the aneurysm was clipped (**c**). ICG videoangiography confirms the patency of parent MCA and the disappearance of flow into the aneurysm (**d**)

media, with accompanying inflammatory changes, T cell and macrophage infiltrations, and release of lytic enzymes [1, 9, 21, 26]. The net effect of this complex remodeling process is a modification of the wall thickness that is readily visible during microsurgical dissection and observation, with thinning regions of the aneurysm dome [15, 16, 18]. If the aneurysm has a thin wall or severe atherosclerotic change, simple neck clipping for this aneurysm causes an aneurysm neck tear or slipping in/out of the clip blade, followed by rupture, stenosis of the parent artery, or dome clipping. The wrap-clipping method has been established as a treatment option for this kind of aneurysm, which can provide reinforcement in holding the applied clip to prevent rupture and enlargement [2, 6, 11]. In the wrap-clipping method, non-autologous materials have been used [2, 11, 17, 19, 29], and the fibrosis induced by these materials is thought to protect against late, but not early, rebleeding of ruptured intracranial aneurysms [12]. In addition, non-autologous materials are also associated with many adverse effects, including foreign body granuloma [3, 20], fibrous scar [34], optochiasmatic arachnoiditis with progressive bilateral vision loss [10, 32], cranial nerve palsy [31], toxic neuropathy [23, 33], infections with encephalitis and abscess or fluid accumulation [5, 8, 20], intraluminal thrombosis with arterial occlusion [4, 5], and parent vessel narrowing [22]. Therefore, the risks of using these non-autologous wrap material must be carefully considered.

On the other hand, the PGA sheet is a soft, transparent, thin material that reacts as an absorbable substitute that resorbs in approximately 15 weeks and has been shown to be safe [7, 36, 37]. The PGA sheet is applicable for various situations, including as an absorbable pleural membrane, offering an effective method for preventing pulmonary fistula [28], the repair of the dura mater for preventing cerebrospinal fluid leakage during spinal surgery [35], and the repair of duodenal ulcer [27]. Contrary to the aforementioned wrapping methods, our sling-wrap clipping method using a PGA sheet could directly obstruct the aneurysm under good visibility through the sheet, avoiding slipping in/out of the clip blade. In this study, the sling-wrap clipping method was shown to be not related to any complications. However, some limitations of this study should be mentioned. First, the authors performed the sling-wrap clipping method for only six patients. Second, the follow-up period was short. Third, our method is a modified clipping method, not a wrapping method. Because the PGA sheet reacts as an absorbable substitute that resorbs in approximately 15 weeks, the reinforcement by the PGA sheet may be lost. Therefore, whether the sling-wrap clipping is also suitable for fusiform aneurysms, which could not be treated by neck clipping, remains unknown. Finally, this method could not be suitable if perforators or the small artery branch from the M2 segment of the MCA, which would be slung up. Therefore, long-term prospective comparative studies will be necessary in the future to confirm the efficiency of this method.

Conclusion

The sling-wrap clipping method using a transparent PGA sheet is another surgical option for thin-walled or severe atherosclerotic MCA aneurysms.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This technical note was approved by the institutional ethics committee of Hyogo College of Medicine.

Informed consent Patient consent was obtained in each case.

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