In Situ Side-to-Side Anastomosis: Surgical Technique and Complication Avoidance

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In situ side-to-side (STS) anastomosis is a unique technique used for intracranial artery–intracranial artery revascularization. Over a 7-year period, 7 STS anastomoses were performed for anterior cerebral artery aneurysms in 6 patients and a posteroinferior cerebellar artery aneurysm in 1 patient. We provide a step-by-step guide for suturing techniques from arteriotomy to vessel wall sutures based on clinical experiences, with detailed illustrations. Technical considerations in each stage are also discussed. The current technique provides a viable option for treatment of complex aneurysms.

INTRODUCTION

The in situ side-to-side (STS) anastomosis technique remains one of the essential skills in the art of intracranial revascularization.[1-3] This technique is unique to neurovascular surgery because 2 neighboring and apposing arteries are seldom observed in the vascular structures of other body parts. In situ anastomoses (e.g., A3 anterior cerebral artery [ACA] to A3 anastomosis, middle cerebral artery to middle cerebral artery anastomosis, superior cerebellar artery to posterior cerebral artery anastomosis, posterior inferior cerebellar artery (PICA) to PICA anastomosis) have been reported as a new treatment strategy for complex aneurysms and shown to have significant advantages in terms of bypass patency rate and aneurysm obliteration.[4-6]

However, because clinical indications requiring STS anastomosis are quite rare, neurosurgeons are often unfamiliar with the technique. Failure of STS anastomosis can cause infarction in both arterial territories. Although surgery in deep and narrow surgical fields or deep bypass surgery necessitates a long-term training period and a high level of manual dexterity, few publications have specifically addressed the suturing technique for STS anastomosis.[7-9] Here we describe a surgical technique for in situ STS anastomosis with detailed illustrations, including key technical lessons learned, expected errors, and their avoidance for each individual stage.

METHODS

Between September 2011 and February 2017, 7 patients with complex aneurysms underwent in situ STS bypass surgery. One neurosurgeon (S.K.C.) performed ACA-ACA bypass in 5 patients and PICA-PICA bypass in 1 patient, and another neurosurgeon (W.S.C.) performed ACA-ACA bypass in 1 patient (Table 1). To describe the technical nuances, key surgical information relevant to STS anastomosis was evaluated. Information on surgical depth, caliber of donor and recipient arteries, length of arteriotomy, number of stitches in the anterior and posterior walls, small branching arteries arising from either side of the vessels, and type of needle were obtained from medical records, radiologic data, and operative video recordings. Ultrasound Doppler and cerebral angiography were performed to assess the patency of postoperative anastomoses.

Operative Technique

In situ STS anastomosis requires an operating microscope; highly advanced microsurgical devices, including fine micro forceps, fine micro scissors, needle holders, and cutting blade; and 9-0 (W2813 and W2898; Ethicon, Somerville, New Jersey, USA) or 10-0 monofilament sutures (W2899, Ethicon). The placement of a continuous suction device using a small drainage tube is essential to maintain a clear surgical corridor.

Two vessels apposed within 5 mm are subjected to STS anastomosis. After approximating the vessels using a rubber dam, temporary mini-clips are applied proximal and distal to the anastomotic site. For a better arteriotomy position, donor and recipient vessels are incised at equal lengths using a cutting blade and fine micro scissors. Special attention should be given to avoid damaging the vessel's posterior wall. The lumens of donor and recipient vessels are irrigated with

Key words
- Cerebral revascularization
- Side-to-side anastomosis
- Surgical technique

Abbreviations and Acronyms
ACA: Anterior cerebral artery
PICA: Posterior inferior cerebellar artery
STS: Side-to-side

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Table 1. Surgical Details of in Situ Side-to-Side Bypasses Performed in Our Series

Case	Location	Surgical Method	Vessel Diameter (mm, L/R)	Arteriotomy Length (mm)	Number of Stitches (Ant/Post)	Branching Artery (L/R)	Surgical Depth (mm)	Approach	Suture (Size, Model)	Temporary Clip Time (Minutes)	Follow-Up (Months)	Patency
1	Acom	A3-A3	1.7/1.7	4.1	6/5	0/2	44	BAIH	9-0 Ethilon, W2813	63	19	Good
2	A2	A3-A3	2.1/1.9	7.2	7/7	0/2	45	BAIH	9-0 Ethilon, W2813	75	56	Good
3	A1	A3-A3	2.0/2.1	6.2	6/6	1/1	41	BAIH	9-0 Ethilon, W2813	67	10	Good
4	PICA	PICA-PICA	1.2/1.2	3.7	4/4	1/0	62	Far lateral	9-0 Ethilon, W2813	64	1	Good
5	A2-A3 junction	Per-CMA	1.5/1.5	5.1	6/6	0/0	43	BAIH	9-0 Ethilon, W2898	60	11	Good
6	A3	Per-CMA	1.5/1.9	6.0	8/8	0/0	43	AIH	9-0 Ethilon, W2898	53	3	Good
7	Acom	A3-A3	1.8/2.1	6.5	5/5	0/0	42	BAIH	10-0 Ethilon, W2899	72	4	Good

L, left; R, right; Ant, anterior wall; Post, posterior wall; Acom, anterior communicating artery; A3, A3 segment of anterior cerebral artery; BAIH, basal anterior interhemispheric approach; A2, A2 segment of anterior cerebral artery; A1, A1 segment of anterior cerebral artery; PICA, posteroinferior cerebellar artery; CMA, calloso-marginal artery; Per, pericallosal artery; AIH, anterior interhemispheric approach.

heparinized saline. Systemic heparinization and/or aspirin medication are not given.

The interrupted suturing technique involves placing sutures at the apex of the arteriotomy in the order of upper then lower stay sutures (Figure 1). This provides for better tissue apposition, and indirect manipulation of the vessels is considered the most important step. Two threads are cut to approximately 50 mm long for easy handling. Each stay suture is tied off using a square knot. The first throw is usually made with a double loop to prevent knot loosening. Both tails of the sutures are intentionally left long, with the upper tail allowing continuous suturing to the posterior wall and the lower tail allowing continuous suturing to the anterior wall.

Using a continuous suturing technique, the posterior wall suture should proceed from the upper apex to the lower apex (Figure 2). The first suture is passed from outside to inside the posterior wall of the left-sided artery and should be close to the upper stay suture. Thus, a right-handed surgeon may struggle to control the suturing needle, because the needle point moves from between 1 and 2 o'clock to between 7 and 8 o'clock in a confined space. The second suture should pierce through in an inside-out fashion and be placed opposite the first suture. Placing the first and second sutures is considered the most complex step in STS anastomosis, being crucial for controlling leakage from the anastomosis. Continuous suturing is then performed, spacing each interval evenly and making the loops as small as possible to prevent

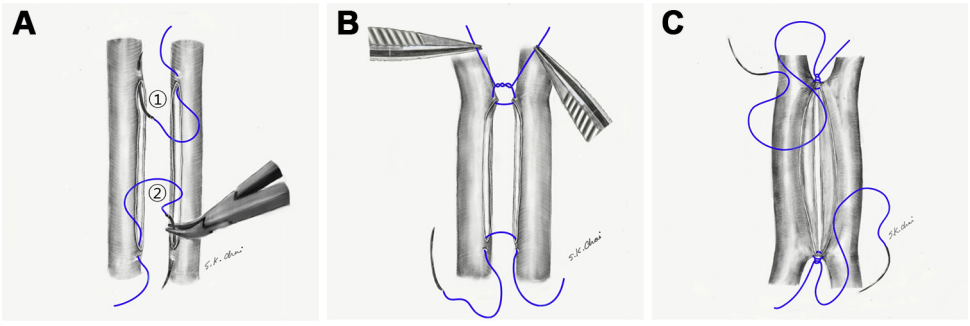

Figure 1. Upper and lower stay sutures. (**A**) The upper stay suture is placed outside to inside at the superior apex of the right artery, then passes from inside the lumen to outside the left artery. The lower stay suture at the inferior edge of the left artery is performed in an outside-in fashion and is then pierced from inside to outside the right artery. (**B**) The first throw with a double loop is performed to effectively prevent knot loosening. Knots were left outside the vessel. (**C**) The tail with the needle at both ends is intentionally left long; the upper tail is used for the continuous suture of the posterior wall, and the lower tail is used for the anterior wall.