Familiarization with contact aspiration using non-penetrating of the thrombus (CANP) technique as the initial procedure for acute ischemic stroke

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ABSTRACT

Background

This study aimed to prove the safety and efficacy of the contact aspiration using non-penetrating of thrombus (CANP) technique for the initial procedure for acute ischemic stroke and to increase operator familiarization with the technical aspects of the CANP technique.

Methods

A total of 103 patients with large-vessel stroke who were treated using thrombectomy alone at our institution between April 2019 and March 2021 were included in this study. CANP technique was performed using a large lumen catheter (inner diameter, ≥0.060 in.) without penetrating a thrombus. Results of the CANP technique, including the procedure time; first-pass effect (FPE); angiographical recanalization; functional independence; thrombus migration; and intracerebral hemorrhage (ICH) were compared with combined technique.

Results

A total of 77 patients (74.8%) were scheduled to undergo the CANP technique for initial procedure, and 50 (64.9%) attempted the CANP technique. Of 50 patients with CANP technique, 33 (66.0%) achieved angiographically good recanalization using CANP technique alone. FPE was achieved in 31 patients (62.0%) in CANP technique group; the rate of FPE was significantly higher ($p = 0.008$). Asymptomatic ICH were significantly smaller in the CANP technique group ($p = 0.008$). The median interval of only the CANP technique was 20 (IQR, 16–29.5) min for groin puncture to final recanalization, and was significantly faster ($p < 0.001$).

Conclusions

CANP technique was safe with low risk of hemorrhagic complication and effective for the initial procedure of acute ischemic stroke.

INTRODUCTION

Thrombectomy, along with intravenous alteplase, had been the standard medical care to achieve rapid and complete reperfusion for acute ischemic stroke(1). Many devices and techniques had been developed and devised, respectively, to achieve rapid and complete reperfusion. Thrombectomy includes stent retriever thrombectomy, with or without aspiration assistance, and contact aspiration (CA), mainly a direct aspiration first-pass

technique (ADAPT). Kang et al. reported CA using a catheter with an inner diameter (I.D.) of 0.041 in.(2). CA had been widely performed with the development of flexible and large bore aspiration catheters. ADAPT was a technique widely used for CA(3, 4), in which microcatheter and microwire are advanced through and distal to the thrombus to provide stable support for the large bore catheter. CA is expected to be an effective, safe, and minimally invasive procedure without mechanically damaging the blood vessels. The debatable point of ADAPT is the inner microcatheter penetrating the thrombus leading to thrombus migration and microvessel perforation. Therefore, the contact aspiration using the non-penetrating of thrombus (CANP) technique was adopted in our institution to reduce the risk of disintegrated thrombus and vessel wall injury.

Therefore, this study aimed to prove the safety and efficacy of the CANP technique as the initial procedure for the management of ischemic stroke and to increase operator familiarization with the technical aspects of this procedure.

METHODS

Patients/ Procedure

All patients who underwent only thrombectomy excluding percutaneous transluminal angioplasty and carotid artery stenting for large-vessel occlusion (LVO) at our institution between April 2019 and March 2021 were included in this study. Recombinant tissue plasminogen activator (rtPA) was intravenously administered according to the Japanese guidelines. Patients who presented within 6 h from the symptom onset or from the time they were last seen well were selected for thrombectomy. Patients with unclear or >6 h time of onset were selected for thrombectomy if a large penumbra area was identified. When the National Institutes of Health Stroke Scale (NIHSS) was >5 and intracerebral hemorrhage (ICH) was ruled out using CT, the patient was included. Patients with large infarct burden on presentation or rapidly resolving symptoms with or without intravenous rtPA administration were excluded. All treatments were performed under local anesthesia. After introducing the sheath, heparin (4000 IU) was intravenously infused, except for those who have received intravenous rtPA. Thrombectomy with stent retriever alone was achieved in each of the three cases of anterior circulation and posterior circulation to introduce thrombectomy for acute ischemic stroke in our institution. Hence, we excluded these six cases treated with stent retriever alone. Until November 2019, the operator chose either the CANP technique or combined technique for the initial procedure. The CANP technique was used as the first-line approach since December 2019. Both the CANP and

combined techniques used the 9F sheath with a balloon guide catheter for anterior circulation or a 6F long sheath for posterior circulation, a large lumen catheter (I.D. ≥0.060 in.), an inner catheter (I.D. 0.027 in.), and a guidewire of 0.014 in. The largest caliber aspiration catheter that the vessel would accommodate was selected for each patient. The operator selected the catheter; usually, a catheter with an I.D. of ≥0.068 in. was selected for the CANP technique, although a catheter with an I.D. =0.060 in. was selected if the patient age was ≥80 years, the vessel anatomy was tortuous, or the location was posterior circulation. The aspiration catheter tip was shaped in 30° with steam, and the length of the shaped tip was 5 mm. Details of the CANP technique are as follows. The proximal edge of the thrombus was recognized according to the behavior of the guidewire and inner catheter. The large lumen catheter was slid and wedged the thrombus by advancing the catheter and pulling the inner catheter and guidewire. After confirming crimping of the thrombus and disappearance of the countercurrent blood flow using a small 10-ml syringe, continuous aspiration was made for 2 min. Aspiration was performed using either manual syringe or pump approved by Pharmaceuticals and Medical Devices Agency. The aspiration catheter was slowly withdrawn while maintaining aspiration with the occlusion of internal carotid artery or common carotid artery occlusion using the balloon guide catheter. If aspiration catheter was not safely reached and crimped to the thrombus, the stent retriever was combined, and the procedure quickly changed to the combined technique. The choice of combined techniques, CAPTIVE(5), SAVE(6), or ASAP(7), including selection of the stent retriever, was made by the operator.

Informed consent was obtained at pretreatment. This study was a single-center retrospective analysis. The endovascular treatment protocol was approved by the institutional review board of Saitama Cardiovascular and Respiratory Center.

Clinical and radiological assessments

The clinical assessment at baseline and upon hospital discharge or 30 days after the stroke onset was underestimated by trained neurosurgeons or neurologists. Several studies usually performed the clinical assessment at 90 days after the stroke onset. In this study, assessment was performed after a short period because of difficulties in providing uniform and steady rehabilitation during the coronavirus disease 2019 pandemic. The clinical assessment was evaluated using the NIHSS at baseline. The functional outcome was assessed using the modified Rankin scale (mRS), and functional independence was defined as mRS of 0–2 or no change in mRS as compared with the premorbid state. We diagnosed thrombus migration when a new distal

occlusion in addition to the primary occlusion was identified using angiography after the initial procedure. The angiographic result was evaluated using the mTICI(8), and good recanalization was defined as mTICI scale of 2b or 3. First-pass effect (FPE) was defined as achieving a good recanalization with a single thrombectomy device pass(9). Symptomatic ICH was defined as an increase of ≥4 points on the total NIHSS or a 1-point increase in the consciousness level on the NIHSS.

Statistical analysis

We performed statistical analysis using JMP 12 (SAS Institute Inc., Cary, NC, USA). Univariate comparisons between two groups were performed using the Wilcoxon's rank sum test or two-sided Fisher exact test. *P*-values of <0.05 were considered to indicate a statistical significance.

RESULTS

Among 77 patients (74.8%) scheduled to undergo the CANP technique for the initial procedure, 50 (64.9%) attempted using the CANP technique and 27 (35.1%) switched to the combined technique (Fig. 1). Patient characteristics and treatment results had no significant differences between patients scheduled with combined technique and those who underwent combined technique after changing the procedure from the CANP technique. Results were examined between the patient who underwent the CANP technique and all patients who underwent the combined technique.

Of the 50 patients who underwent CANP technique, 28 were men and 22 women, with a median age, NIHSS and DWI-ASPECTS of 76 (interquartile range [IQR], 67–84.25), 18 (IQR, 13.5–22), and 7 (IQR, 5–9) years, respectively. The LVO site was the internal carotid artery (ICA), the ICA to middle cerebral artery (MCA), the horizontal segment of MCA, and the basilar artery in 19, 1, 24, and 6 patients, respectively. The cause of stroke was cardioembolic, atherosclerosis, Trousseau syndrome, artery dissection, and noncardiac embolism in 35, 5, 4, 2, and 4 patients, respectively. Intravenous rtPA was administered to 5 patients. The LVO site provided a statistical difference in patient characteristics between the CANP technique and combined technique (Table 1).

FPE was achieved in 31 patients (62.0%), angiographically good recanalization using the CANP technique alone in 33 (66.0%), and additional rescue procedure was required in the CANP technique group in 17 (34.0%). Three patients with symptomatic ICH and one with asymptomatic ICH were acknowledged in the CANP technique group. One patient suffered symptomatic ICH with hemorrhagic cerebral infarction, and no

asymptomatic ICH occurred in the CANP technique without additional combined technique. The median interval from groin puncture to final recanalization using the CANP technique was 27 (IQR, 18–37) min and of only CANP technique alone without additional combined technique was 20 (IQR, 16–29.5) min. The FPE rate and median intervals from the groin puncture to final recanalization were significantly higher in the CANP technique group than that in the combined technique ($p = 0.008$ and $p < 0.001$). Asymptomatic ICH was significantly smaller in the CANP technique group than that in the combined group ($p = 0.008$). CANP technique had a low tendency to occur thrombus migration with the initial procedure than the combined technique ($p = 0.224$) (Table 2).

DISCUSSION

Overall, our findings suggest that the use of CANP technique as the initial procedure for LVO stroke may achieve high FPE and safety reperfusion. Functional independence after LVO stroke is caused by rapid and complete reperfusion. However, which technique should be applied for the initial procedure to achieve quick and efficient reperfusion for LVO stroke is an ongoing debate. Mechanical thrombectomy with stent retriever has been a predominant procedure at an early thrombectomy era(10). CA combined with the development of flexible, and large bore aspiration catheter with high trackability has been used with “ADAPT” as an especially and widely spread representative method. Our results compared favorably with the findings of a previous study on ADAPT(11). Some studies presented the noninferiority of ADAPT as compared with stent retriever(12-14). If simple aspiration alone was unsuccessful, the aspiration catheter serves as a conduit of stent retriever and as an aspiration catheter with combined technique. ADAPT was a safe and effective procedure for the initial thrombectomy, whereas it was associated with a higher rescue procedure requirement(15). The combined technique was classified based on the use of a balloon guide catheter, timing of aspiration, and positional relation between the stent retriever and aspiration catheter. Various procedures of combined technique such as CAPTIVE(5), SAVE(6), or ASAP(7) exist. Combined technique as a first-line strategy was reported to obtain higher good recanalization with higher risk of bleeding as compared with CA(14, 16). Switching procedure from ADAPT to the combined technique improved the successful revascularization(17). However, aspiration catheter combined with stent retriever led to high production costs(18).

As mentioned above, CA offered some advantages, including simple and rapid procedure and removal of thrombus alone unaccompanied by vessel injury with metallic

devices, and some disadvantages of rescue procedure requirement. The CANP technique was expected to maximize the CA merits and minimize its disadvantages. The common method in conventional thrombectomy, including thrombectomy with a stent retriever alone, ADAPT, and the combined technique, was penetrating the thrombus using an inner microcatheter and guidewire. This occasionally induced the thrombus to the distal vessel, destruct thrombus, and injure the vessel walls plugged with the thrombus and located distal from the thrombus. Non-penetrating thrombus procedure with the CANP technique was associated with the prevention of pushing and damaging the thrombus, and vessel wall invasion. For instance, if the clot was located on the vessel after the clipping procedure of the intracranial bifurcation aneurysm, the operator hesitated to pass through the clipping segment with the microcatheter, expand the stent retriever, and pull the stent retriever with rubbing the clipping segment. This CANP technique had an effect procedure to prevent vessel invasion (Fig. 2). The extent of arterial wall damage with each thrombectomy technique in vitro and in vivo has not been established yet (19, 20), but no angiographic vasospasm was confirmed in either of the techniques. Our results revealed that the CANP technique might help to retrieve one lump of thrombus without the debris of clot occurred with thrombus damage and reduction of the thrombus migration. Asymptomatic ICH, including a small amount of subarachnoid hemorrhage, was usually caused by vessel wall injury and vessel tension. Asymptomatic ICH was significantly decreased in the CANP technique group than the combined technique group in our study. Symptomatic ICH occurred in all procedures, three hemorrhagic infarctions after recanalization in the CANP technique group, one hemorrhagic infarction, and one subarachnoid hemorrhage with ICH caused by perforator tension in combined technique, and one ICH caused by perforator tension in the solo stent retriever technique in our study. Altogether, the CANP technique might be a safe procedure particularly for those with a bleeding complication, as CA was previously reported to have a low risk of bleeding than the combined technique(14, 16). The CANP technique group obtained a significantly higher FPE than the combined technique group. This FPE rate (62.0%) with the CANP technique was comparatively high compared with previous reports, although the large number of vessel sites with the CANP technique was ICA(9, 21, 22). The cause of high FPE was suggested to prevent pushing and damaging the thrombus and sufficient wedge between the catheter tip and the thrombus. Non-penetrating thrombus procedure using the CANP technique was also related to shortened procedure time by excluding the selection of distal vessels. Rescue procedure was performed in approximately one-third of patients in the CANP technique group without significant difference compared with the combined technique group. The

rate of rescue procedure in our study was equal to that of previous studies(11, 15). The number of initial procedure attempts in the CANP technique group was significantly smaller than the combined technique group, with the single CANP technique as a majority. The effectiveness of plurality of CANP techniques was not identified, and the CANP technique was rapid, effective, and safe for initial procedure for LVO stroke. Finally, the development of devices, especially flexible and large bore aspiration catheter, enabled the catheter with the CANP technique to reach the thrombus, even if the vessel anatomy was tortuous (Fig. 3). CANP technique was a significantly rapid procedure and approximately one-third of patients in the CANP technique group changed the initial procedure to the combined technique. The loss of the time caused by changes in the initial procedure from the CANP technique to the combined technique did not occur in our study, and the development of aspiration catheters with high trackability or self-inductivity was expected.

The single-center and retrospective design and the small number of patients are the major limitations of this study. The potential selection bias was also a limitation. However, the single-center and short-term result ensured consistent approaches, managements, and endovascular techniques for LVO stroke, and reflected a real-world data. The number of procedure attempts was not uniform, and the effectiveness of plurality of CANP technique was not identified. Furthermore, the functional outcome was evaluated in a shorter period than previous studies(23, 24), and a longer evaluation at 90 days after the stroke onset may be required.

Conclusions:

The CANP technique was found to be safe with low risk of hemorrhagic complication and an effective with high FPE as the initial procedure for the management of LVO stroke.

Fig. 1 Procedure diagram

Fig. 2

A 69-year-old woman, NIHSS on admission: 23, right MCA occlusion, past history of intracranial aneurysm of middle cerebral artery bifurcation with clipping (black arrow).
A: Initial CT showed hyperdense sign on MCA (white arrow) just by the clip.
B: Initial angiography of ICA showed artery occlusion on the right horizontal segment of MCA close to the clip of aneurysm.

C: Complete recanalization appeared on angiography of ICA after a simple CANP technique with aspiration catheter (I.D. 0.060 in.).

Fig. 3
A 52-year-old man, NIHSS on admission: 21, right ICA occlusion
A: Initial angiography of ICA showed stagnation of contrast in the cervical portion of ICA. B: A fusion image of preaspiration image and postaspiration image revealed the aspiration catheter tip (I.D. = 0.071 in.) on ophthalmic segment of ICA [22].
C, D: Complete recanalization appeared on angiography of ICA after a simple CANP technique.
E: The thrombus presented one lump of a large dark-red fibrous thrombus

References:

1. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. The New England journal of medicine 2015;372:1019-1030.
2. Kang DH, Hwang YH, Kim YS, et al. Direct thrombus retrieval using the reperfusion catheter of the penumbra system: forced-suction thrombectomy in acute ischemic stroke. AJNR American journal of neuroradiology 2011;32:283-287.
3. Turk AS, Spiotta A, Frei D, et al. Initial clinical experience with the ADAPT technique: a direct aspiration first pass technique for stroke thrombectomy. Journal of neurointerventional surgery 2014;6:231-237.
4. Turk AS, Frei D, Fiorella D, et al. ADAPT FAST study: a direct aspiration first pass technique for acute stroke thrombectomy. Journal of neurointerventional surgery 2014;6:260-264.
5. McTaggart RA, Tung EL, Yaghi S, et al. Continuous aspiration prior to intracranial vascular embolectomy (CAPTIVE): a technique which improves outcomes. Journal of neurointerventional surgery 2017;9:1154-1159.
6. Maus V, Behme D, Kabbasch C, et al. Maximizing First-Pass Complete Reperfusion with SAVE. Clin Neuroradiol 2018;28:327-338.
7. Goto S, Ohshima T, Ishikawa K, et al. A Stent-Retrieving into an Aspiration Catheter with Proximal Balloon (ASAP) Technique: A Technique of Mechanical Thrombectomy. World neurosurgery 2018;109:e468-e475.
8. Zaidat OO, Yoo AJ, Khatri P, et al. Recommendations on angiographic revascularization grading standards for acute ischemic stroke: a consensus statement. Stroke; a journal of cerebral circulation 2013;44:2650-2663.
9. Zaidat OO, Castonguay AC, Linfante I, et al. First Pass Effect: A New Measure for Stroke Thrombectomy Devices. Stroke; a journal of cerebral circulation 2018;49:660-666.

10. Badhiwala JH, Nassiri F, Alhazzani W, et al. Endovascular Thrombectomy for Acute Ischemic Stroke: A Meta-analysis. JAMA : the journal of the American Medical Association 2015;314:1832-1843.
11. Gory B, Armoiry X, Sivan-Hoffmann R, et al. A direct aspiration first pass technique for acute stroke therapy: a systematic review and meta-analysis. Eur J Neurol 2018;25:284-292.
12. Lapergue B, Blanc R, Gory B, et al. Effect of Endovascular Contact Aspiration vs Stent Retriever on Revascularization in Patients With Acute Ischemic Stroke and Large Vessel Occlusion: The ASTER Randomized Clinical Trial. JAMA : the journal of the American Medical Association 2017;318:443-452.
13. Turk AS, 3rd, Siddiqui A, Fifi JT, et al. Aspiration thrombectomy versus stent retriever thrombectomy as first-line approach for large vessel occlusion (COMPASS): a multicentre, randomised, open label, blinded outcome, non-inferiority trial. Lancet 2019;393:998-1008.
14. Texakalidis P, Giannopoulos S, Karasavvidis T, et al. Mechanical Thrombectomy in Acute Ischemic Stroke: A Meta-Analysis of Stent Retrievers vs Direct Aspiration vs a Combined Approach. Neurosurgery 2020;86:464-477.
15. Kang DH, Kim JW, Kim BM, et al. Need for rescue treatment and its implication: stent retriever versus contact aspiration thrombectomy. Journal of neurointerventional surgery 2019;11:979-983.
16. Delgado Almandoz JE, Kayan Y, Young ML, et al. Comparison of clinical outcomes in patients with acute ischemic strokes treated with mechanical thrombectomy using either Solumbra or ADAPT techniques. Journal of neurointerventional surgery 2016;8:1123-1128.
17. Pampana E, Fabiano S, De Rubeis G, et al. Switch Strategy from Direct Aspiration First Pass Technique to Solumbra Improves Technical Outcome in Endovascularly Treated Stroke. Int J Environ Res Public Health 2021;18.
18. Comai A, Haglmüller T, Ferro F, et al. Sequential endovascular thrombectomy approach (SETA) to acute ischemic stroke: preliminary single-centre results and cost analysis. Radiol Med 2015;120:655-661.
19. He G, Deng J, Zhang Y, et al. Mechanical thrombectomy injury to the arterial wall: A comparison between catheter aspiration and stent retriever. Eur J Radiol 2021;139:109723.
20. Teng D, Pannell JS, Rennert RC, et al. Endothelial trauma from mechanical thrombectomy in acute stroke: in vitro live-cell platform with animal validation. Stroke; a journal of cerebral circulation 2015;46:1099-1106.
21. Pérez-García C, Maegerlein C, Rosati S, et al. Impact of aspiration catheter size on first-pass effect in the combined use of contact aspiration and stent retriever technique. Stroke Vasc Neurol 2021.

22. Abbasi M, Liu Y, Fitzgerald S, et al. Systematic review and meta-analysis of current rates of first pass effect by thrombectomy technique and associations with clinical outcomes. Journal of neurointerventional surgery 2021;13:212-216.
23. Sardar P, Chatterjee S, Giri J, et al. Endovascular therapy for acute ischaemic stroke: a systematic review and meta-analysis of randomized trials. Eur Heart J 2015;36:2373-2380.
24. Goyal M, Menon BK, van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. Lancet 2016;387:1723-1731.

Table 1. Patient characteristics and time course at pretreatment

	CANP technique (n = 50)	Combined technique [switch procedure] (n = 47[27])	*p*- value
Patient characteristics			
Sex, male/female	22/28	26/21 [16/11]	0.312
Age, median (IQR), years	76 (67-84.25)	80 (75-86) [78 (74-86)]	0.118
Present status on admission			
NIHSS, median (IQR)	18 (13.5-22)	17 (14-22) [17 (15-23)]	0.735
Vessel site of LVO			
ICA	19	8 [5]	0.022*
ICA - MCA	1	4 [2]	
MCA (horizontal segment)	24	33 [19]	
BA	6	2 [1]	
DWI-ASPECTS, median (IQR)	7 (5-9)	7 (6-8) [7 (5.5-8.5)]	0.367
CT-ASPECTS, median (IQR)	8 (6.75-9)	8 (6-9) [8 (6.5-9)]	0.813
Time course			
Time from symptom onset or from time last seen well to admission, median (IQR), min	117.5 (58.75-238.75)	143 (68-270) [100 (65-400)]	0.561
Time from admission to puncture, median (IQR), min	52 (43-65)	56 (47.75-66) [55 (45-61)]	0.417

NIHSS, National Institutes of Health Stroke Scale; LVO, large-vessel occlusion; ICA, internal carotid artery; MCA, middle cerebral artery; BA, basilar artery; DWI, diffusion-weighted imaging; ASPECTS, Alberta Stroke Program Early CT Score; *p* -value: CANP technique vs combined technique

Table 2. Treatment results

	CANP technique (n = 50)	Combined technique [switched procedure] (n = 47[27])	*p*- value
Number of initial procedure attempts	1 (1-1)	1 (1-2) [1 (1-2)]	<0.001*
FPE	31 (62.0%)	16 (34.0%) [8 (29.3%)]	0.008*
Thrombus migration	4 (8.0%)	8 (17.0%) [5 (18.5%)]	0.224
Rescue procedure	17 (34.0%)	15 (31.9%) [11 (40.7%)]	1
final mTICI scale 2b or 3	47 (94.0%)	42 (89.3%) [22 (81.4%)]	0.478
Asymptomatic ICH	4 (8.0%)	14 (29.8%) [10 (37.0%)]	0.008*
Symptomatic ICH	3 (6.0%)	2 (4.3%) [1 (3.7%)]	1
mRS 0-2 at hospital discharge or 30 days after stroke onset	25 (50.0%)	19 (40.4%) [10 (37.0%)]	0.416
Time course			
Time from groin puncture to final recanalization, median (IQR), min	27 (18-37)	45.5 (30-64.25) [47 (33.75-72.75)]	<0.001*

FPE, first-pass effect; mTICI, modified Treatment in Cerebral Ischemia Scale; mRS, modified Rankin scale; ICH, intracerebral hemorrhage

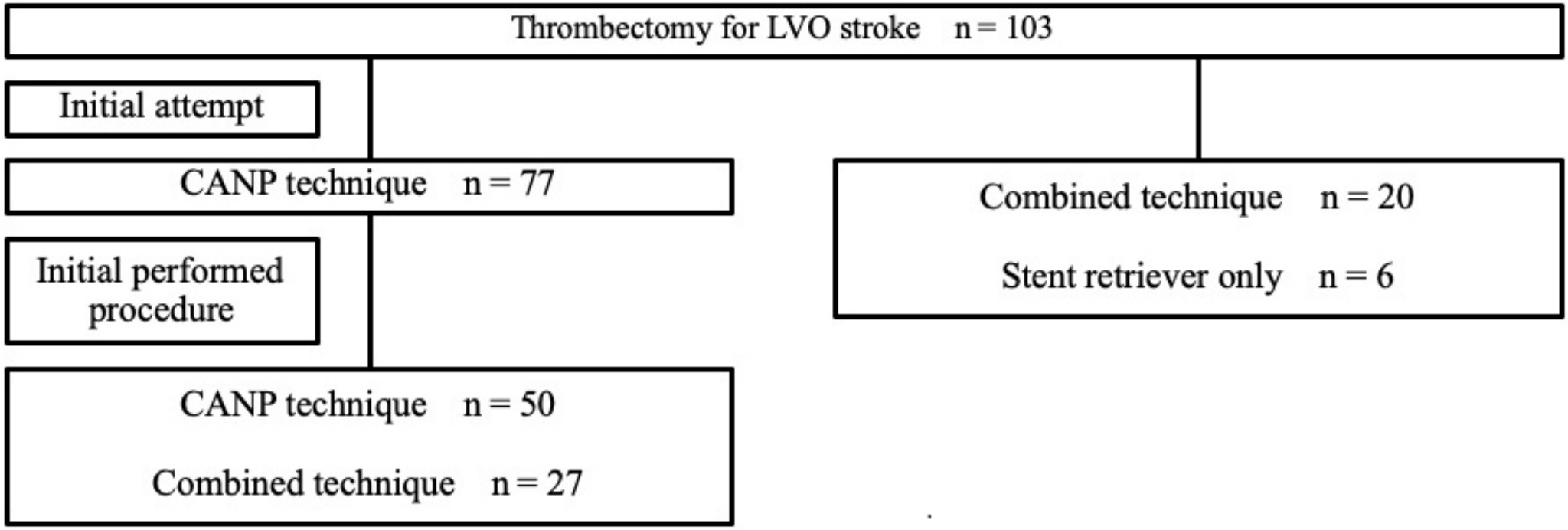
Thrombectomy for LVO stroke n = 103
Initial attempt
CANP technique n = 77
Initial performed procedure
CANP technique n = 50
Combined technique n = 27
Combined technique n = 20
Stent retriever only n = 6

Figure 1

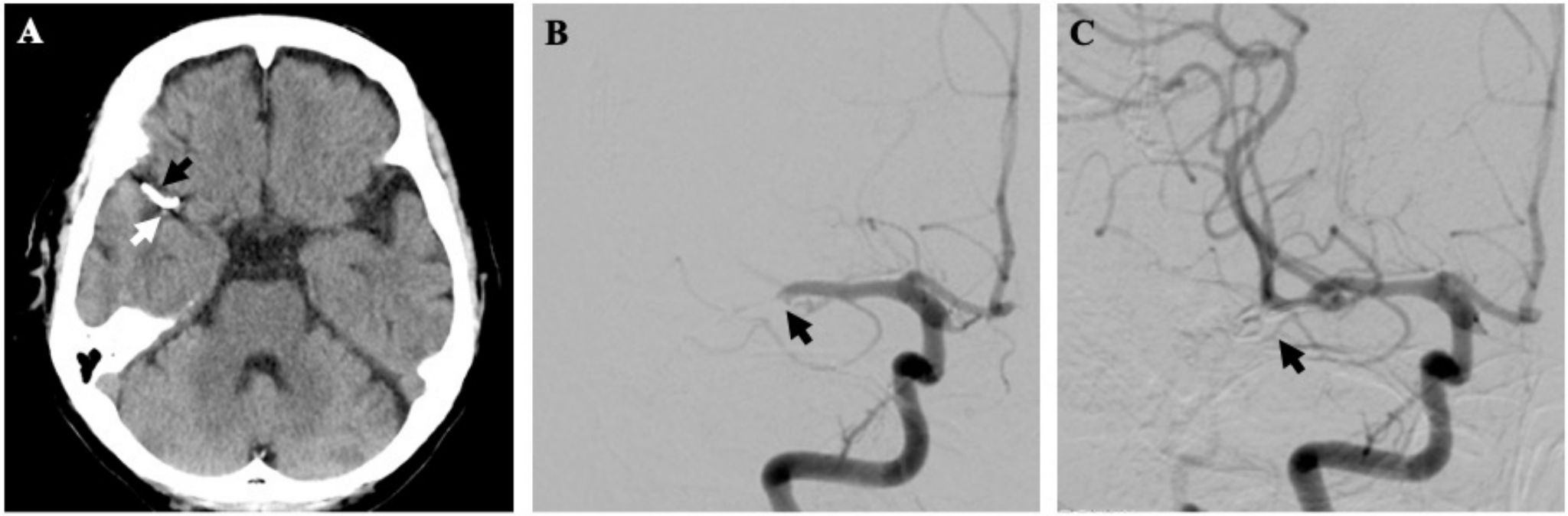

Figure 2

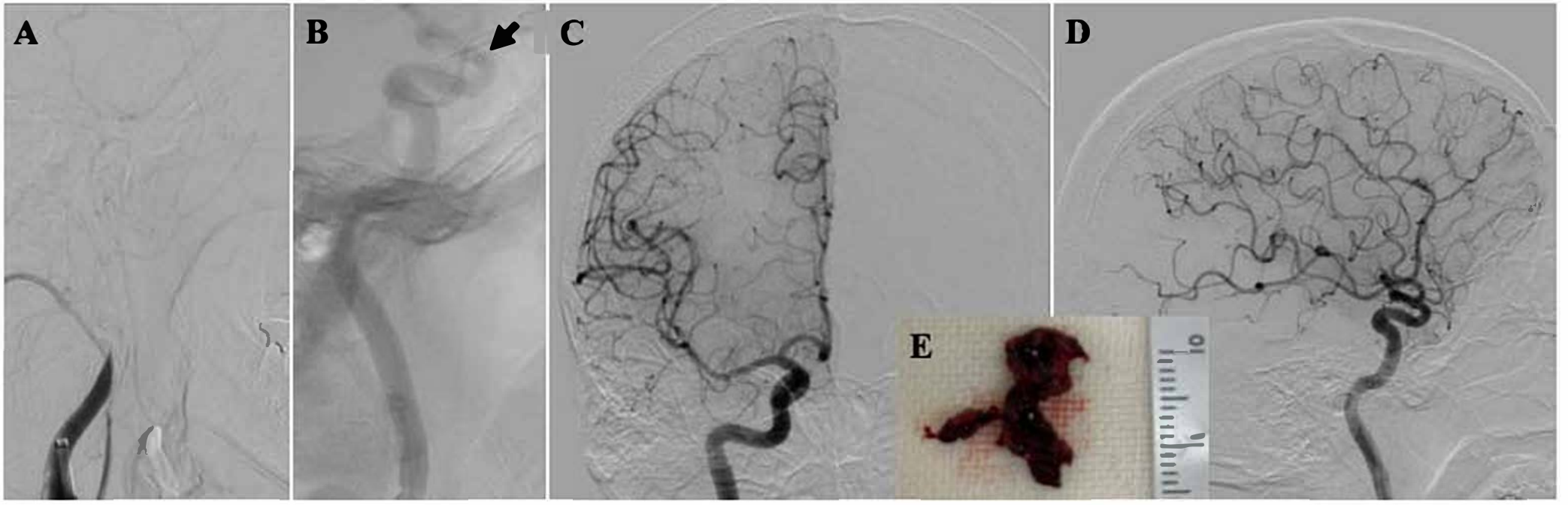

Figure 3