Intra-Arterial Thrombolysis Using Double Devices: Mechanicomechanical or Chemicomechanical Techniques

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Objective: To optimize the recanalization of acute cerebral stroke that were not effectively resolved by conventional intraarterial thrombolysis (IAT), we designed a double device technique to allow for rapid and effective reopening. In this article, we describe the feasibility and efficacy of this technique.

Methods: From January 2008 to September 2009, twenty patients with acute cerebral arterial occlusion (middle cerebral artery: n=12; internal carotid artery terminus: n=5; basilar artery: n=3) were treated by the double device technique. This technique was applied when conventional thrombolytic methods using drug, microwires, microcatheters and balloons did not result in recanalization. In the double device technique, two devices are simultaneously placed at the lesion (for example, one microcatheter and one balloon or two microcatheters). Chemicomechanical or mechanicomechanical thrombolysis was performed simultaneously using various combinations of two devices. Recanalization rates, procedural time, complications, and clinical outcomes were analyzed.

Results: The initial median National Institute of Health Stroke Scale (NIHSS) was 16 (range 5-26). The double device technique was applied after conventional IAT methods failed. Recanalization was achieved in 18 patients (90%). Among them, 55% (11 cases) were complete (thrombolysis in cerebral infarction 2B, 3). The median thrombolytic procedural time including the conventional technique was 135±83.7 minutes (range 75-427). Major symptomatic hemorrhages (neurological deterioration ≥4 points in NIHSS) developed in two patients (10%). Good long term outcomes (modified Rankin Scale ≤2 at 90 days) occurred in 25% (n=5) of the cases. Mortality within 90 days developed in two cases (10%).

Conclusion: The double device technique is a feasible and effective technical option for large vessel occlusion refractory to conventional thrombolysis.

Key Words: Acute · Stroke · Thrombolysis · Double devices.

INTRODUCTION

Recanalization of large cerebral artery occlusions by intraarterial thrombolysis (IAT) is difficult and conventional techniques using local thrombolytic drug infusion often fail1,2. In our practice, chemical thrombolysis alone is rarely successful. Therefore, for many cases, mechanical methods are frequently applied for patients with large cerebral artery occlusions. Whether combined with other methods or done alone, mechanical methods that use wires, balloons and stents have produced better results in terms of high recanalization rates and few hemorrhagic complications3,7,10,11. However, in many of our cases, a single mechanical technique using a single device has not often been enough to reopen the occluded vessels. Therefore, we have used several kinds of mechanical thrombolytic devices, such as wires, balloons and stents, alternatively in our practice. The choice of device was made so that the least traumatic device was used before those that are more traumatic. Thus, we had to withdraw devices from time to time in order to introduce another mechanical device or to infuse thrombolytic agents locally. In our experience, exchanging devices during IAT was troublesome and in many cases, technically difficult, time consuming and risky.
To overcome these difficulties, we designed a double device technique in which we place two devices at the lesion through one large bore guiding catheter. The combination of the two devices varies (e.g., a microcatheter and other mechanical device such as a microwire, balloon, soft coil or stent or two different mechanical thrombolytic devices). While the mechanical thrombolysis is performed, thrombolytic agents are infused simultaneously through the microcatheter, a selective angiogram is obtained, or another mechanical thrombolysis can be performed without exchanging devices. Since this technique was introduced, we have applied it in several acute stroke cases where there were difficulties in reopening the occluded vessels with conventional methods. The purpose of this study was to evaluate the feasibility and efficacy of the double device thrombolysis technique.

**MATERIALS AND METHODS**

Our institutional review board approved this retrospective study, and all patients gave written informed consent for their treatment.

From January 2008 to September 2009, 111 patients with acute ischemic stroke were treated with IAT in our institute. Among them, 20 acute stroke patients were treated by the double device technique because rapid recanalization could not be achieved with the conventional techniques that used single device or multiple devices with exchange methods. The mean age of the patients was 66 years (range 43-87). Four patients were females. The occlusion sites were as follows: middle cerebral artery (n=12; 60%), internal carotid artery terminus (ICAT) (n=5; 25%), and basilar artery (n=3; 15%).

**IAT criteria and procedure**

IAT was indicated when the following conditions occurred: 1) large cerebral artery occlusion, 2) 3-8 hr time window, 3) no intracranial hemorrhage, 4) perfusion-diffusion mismatching on magnetic resonance (MR) imaging, 5) initial National Institute of Health Stroke Scale (NIHSS) ≥4, 6) no response to intravenous tissue plasminogen activator (IVtPA) if IVtPA is indicated. Endovascular procedures were performed through a femoral artery under local anesthesia occasionally with the aid of sedative agents (midazolam and propofol). A biplane angiography unit (Integris Allura 12/12 : PHILIPS, Netherlands) was used. No heparin was given during the procedure. A selective angiography was performed at the same time using microwires, coils (GDC-soft SR 2×6 mm : Boston Scientific, USA), balloons (Hyperglide : ev3, USA, or various coronary balloons), or stents (Enterprise : Cordis, USA and various coronary stents). Sometimes two occluded branches were managed simultaneously with the two devices (Fig. 1, 2). Recanalization was assessed by a thrombolysis in cerebral infarction (TICI) grading system

Recanalization was achieved in 18 patients (90%) and among them, 11 were complete recanalizations

**RESULTS**

The clinical and neuroradiological characteristics and kinds of devices used for the double device technique are summarized in Tables 1 and 2. The median initial NIHSS was 16 (range 5-26). Patients in the combined group (n=8) received IVtPA (0.6 mg/kg) before IAT and the patients in the IAT only group (n=12) received IAT only. The overall median intra-arterial urokinase dose was 250000±1900 U (range 0-700000). Median urokinase doses were 200000±2300 U (range 100000-700000) and 320000±1900 U (range 0-650000) in the IAT only and combined groups, respectively. In one case, no thrombolytic agents were used.

The median interval of time to treatment from stroke onset to thrombolysis was 100±35.6 minutes (range 70-210). The median thrombolytic procedure time from femoral artery puncture to finishing of procedure was 135±83.7 minutes (range 75-427).

Any grade of recanalization was achieved in 18 patients (90%) and among them, 11 were complete recanalizations.
have been proposed in those cases refractory to simple thrombolysis\textsuperscript{1,8,14}. However, the efficacy of a single method has often been unsatisfactory. In our experience, chemical thrombolysis alone has rarely been successful. Mechanical thrombolysis, which offers advantages in terms of efficacy and safety of IAT, is often not able to reopen the occluded vessels when performed as a single mechanical technique using a single device. Also, unlike previous study\textsuperscript{3}, for several months after the original Penum-

**DISCUSSION**

For treatment of acute stroke cases, a variety of IAT techniques have been proposed in those cases refractory to simple thrombolysis\textsuperscript{1,3}\textsuperscript{18}. However, the efficacy of a single method has often been unsatisfactory. In our experience, chemical thrombolysis alone has rarely been successful. Mechanical thrombolysis, which offers advantages in terms of efficacy and safety of IAT, is often not able to reopen the occluded vessels when performed as a single mechanical technique using a single device. Also, unlike previous study\textsuperscript{3}, for several months after the original Penum-

(TICI 2B in 9, TICI 3 in 2). Three procedure-related complications developed in 3 patients: iatrogenic carotid dissection, cerebral artery (M2) perforation and thrombi at the ophthalmic artery. The carotid dissection was successfully treated with a stent. Blood leakage from the M2 perforation was controlled with a temporary M2 occlusion with platinum coils. The ophthalmic artery thrombus was resolved by infusion of a thrombolytic agent. Recovery from these complications was confirmed by follow-up angiograms.

Post-procedural hemorrhage was detected on CT in five patients (25%). Of these, 2 patients (10%) were symptomatic. One patient, who had a cerebellar hemorrhage, underwent decompressive surgery because of brain stem compression and had a mRS at 90 days of 5. The other patient received conservative management and had a mRS at 90 days of 4.

Five patients (25%) had good long term outcomes with mRS scores ≤2 at 90 days after procedure. In two patients (10%), mortality caused by a massive infarction and associated brain edema occurred within 90 days after the procedure.
### Table 1. Summary of the characteristics of the patients, procedural results, and occlusion location

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<th>IVtPA dose (mg)</th>
<th>UK dose (U) (K=×10^6)</th>
<th>GPIIb/IIIa inhibitor</th>
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are known to be difficult lesions to reopen and these occlusions often need aggressive thrombolytic techniques\(^2,8,9\). The overall hemorrhagic rate in our study was 25% with the symptomatic hemorrhagic rate being 10%. This rate is similar to results seen in previous trials of stroke cohorts\(^4,13\). Again, of note, all of our cases were refractory to conventional IAT.

The median procedural time in our study was 2.25 hours. This time is similar to previous studies with conventional methods\(^4,13\). However, it is important to consider that the double device technique in our series was performed only in cases refractory to conventional thrombolysis and the procedural time in our study includes the time of conventional IAT.

The prominent advantage of the double device thrombolysis technique is the practical easiness. The conditions of the lesion site changes as thrombolysis progresses. If one microcatheter is present at the lesion with a mechanical device manipulated, we can figure the changes anytime by selective angiograms without exchanging devices. Thrombolytic agents can be locally infused simultaneously with mechanical thrombolysis. Proximal and distal parts of the occluding thrombi can also be dissolved at the same time and two distal occluded vessels can be managed together. These simultaneous procedures are often necessary when the time window is this close. Thus, we have shown that we can reduce procedural times and the frequency of device exchange during IAT.

The limitations of this study include it being a retrospective analysis, that it occurred at a single institute, and in the small number of cases. It is obvious that larger prospective, multi-institutional studies are necessary to prove the feasibility and safety of this technique. However, our study suggests that a double device technique might be useful for intractable large vessel occlusions not treatable by conventional techniques.

**CONCLUSION**

The double device thrombolysis technique is a feasible and effective technical option of IAT for acute stroke cases which are refractory to conventional thrombolysis.

**References**


