Recanalization Therapy for Internal Carotid Artery Occlusion Presenting as Acute Ischemic Stroke

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Background: We aimed to describe the current status and clinical outcomes of recanalization therapy for internal carotid artery occlusion (ICAO) presenting as acute ischemic stroke. *Methods:* Using a nationwide stroke registry database in Korea, we identified consecutive ischemic stroke patients with ICAO hospitalized within 12 hours of onset between March 2010 and November 2011. *Results:* ICAO accounted for 10.6% (322 of 3028) of acute ischemic strokes within 12 hours of onset. Among the 322 ICAO patients, 53% underwent recanalization therapy, 41% intravenous thrombolysis (IVT) alone, and 59% endovascular treatment (EVT). Twenty-two percent of those with mild deficits (National Institutes of Health Stroke Scale <4) and 50% of those 80 years of age or more received recanalization therapy. Compared with no treatment, recanalization therapy was not significantly associated with a favorable outcome (3-month modified Rankin scale, 0-2) (adjusted odds ratio [OR], 1.77; 95% confidence interval [CI], .80-3.91; $P = .16$). However, compared with IVT, EVT significantly improved the odds of favorable outcome (OR, 2.86; 95% CI, 1.19-6.88; $P = .02$) without significant increase of symptomatic intracranial hemorrhage (OR, 2.18; 95% CI, .42-11.43; $P = .36$) and 3-month mortality (OR, .53; 95% CI, .23-1.18; $P = .12$). Successful recanalization rate (Thrombolysis in Cerebral

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Infarction ≥2a) by EVT was 76%. *Conclusions:* In Korea, one tenth of acute ischemic stroke was caused by ICAO, and about 50% were treated by recanalization therapy. EVT was widely used as a recanalization modality (about 60% of cases) despite lack of evidence. However, its effectiveness and safety were acceptable. **Key Words:** Endovascular recanalization—thrombolysis—carotid artery—acute stroke—revascularization.

Internal carotid artery occlusion (ICAO) accounts for 8.8%-9.1% cases of acute ischemic stroke[1,2] and results in an extremely poor outcome.[3] Recanalization rates of ICAO by intravenous (IV) administration of tissue plasminogen activator (tPA) are only 4%-8%.[4,5]

To overcome the low recanalization rate of IV tPA, new generation endovascular devices have been developed with rapid progress,[6] and use of these devices in ICAO yielded 63%-100% recanalization rates.[7-9] However, clinical trials to compare the possible options of recanalization therapy and determine the best are lacking, and no clear treatment guidelines exist.[10,11] Moreover, the current status of treatment regimens at a national level has not been known well.

Aims

This study aimed to explore the use of recanalization therapy, the methods used for this therapy, and the clinical outcomes among acute ischemic stroke patients with ICAO presenting within 12 hours of the onset of symptoms. Data were derived from a nationwide stroke registry database in Korea.

Methods

Since 2006, the Clinical Research Center for Stroke project sponsored by the Korean Government has begun to facilitate multicenter collaborative stroke research and to develop and implement clinical practice guidelines for stroke in Korea. For achieving these purposes, information on demographics, stroke characteristics, vascular risk factors, diagnostic work-up, in-hospital management, and clinical outcomes of stroke patients who are admitted to participating hospitals are collected prospectively through a web-based stroke registry database (http://www.stroke-crc.or.kr/ecrf).

Our study was designed as a retrospective observational study in the 10 university hospitals or regional stroke centers participating in the fifth subdivision of Clinical Research Center for Stroke, which is dedicated to epidemiologic research. Consecutive patients with ischemic stroke or transient ischemic attack (TIA), who were hospitalized within 12 hours of onset between March 2010 and November 2011, were identified using the registry database. Among them, patients with ICAO diagnosed by magnetic resonance or computed tomography (CT) angiography, carotid duplex, or conventional cerebral angiography and with relevant acute ischemic lesions on magnetic resonance imaging or CT in case of ischemic stroke or relevant symptoms in case of TIA were enrolled for this study.

From the registry database, we obtained demographics, risk factors, initial stroke severity as indexed by the National Institutes of Health Stroke Scale (NIHSS), stroke subtype according to the Trial of ORG 10172 in Acute Stroke Treatment classification,[12] onset-to-arrival time, ICAO location, comorbid intracranial artery occlusion, modalities of recanalization therapy, endovascular devices and the modified Rankin Scale (mRS), and mortality at 3 months.

In addition, the conventional cerebral angiography for patients who received endovascular treatment (EVT) and the CT or magnetic resonance imaging with/without angiography for patients who underwent any type of recanalization therapies were assembled and the recanalization status and the development of symptomatic intracerebral hemorrhage (sICH) were assessed by a core laboratory retrospectively. In patients treated with recanalization therapy, follow-up brain imaging was carried out not routinely but if a patient had any neurologic deterioration.

To describe the status of recanalization therapy according to baseline NIHSS and onset-to-arrival time, baseline NIHSS was categorized into the following categories: 0-3 (mild), 4-9 (moderate), 10-25 (severe), and 26-44 (profound). Onset-to-arrival time was divided into 0-3 hours, 3-6 hours, and 6-12 hours. Stroke onset time was defined as the time when patients were lastly seen normal. Methods of EVT were categorized as follows: (1) intra-arterial (IA) lytics, IA use of chemical thrombolytic agents; (2) microcatheter, multiple passes of the aggressive microcatheter and microwire clot maceration[13]; (3) mechanical thrombectomy, use of devices, such as the Penumbra System and the Solitaire, to perform mechanical clot disruption; and (4) carotid stent placement.

Favorable outcome was defined as 3-month mRS scores of 0-2, sICH as deterioration in NIHSS of ≥4 points with parenchymal hematoma type 2 (Safe Implementation of Thrombolysis in Stroke-MOnitoring STudy definition),[14] and successful recanalization was the Thrombolysis in Cerebral Infarction (TICI) grade ≥2a. The TICI grade was assessed by two experienced stroke neurologists