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Procedural Factors Associated With Percutaneous Coronary Intervention-Related Ischemic Stroke

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Objectives This study sought to determine whether procedural factors during percutaneous coronary intervention (PCI) are associated with the occurrence of ischemic stroke or transient ischemic attack (PCI-stroke).

Background Stroke is a devastating complication of PCI. Demographic predictors are nonmodifiable. Whether PCI-stroke is associated with procedural factors, which may be modifiable, is unknown.

Methods We performed a single-center retrospective study of 21,497 PCI hospitalizations between 1994 and 2008. We compared procedural factors from patients who suffered an ischemic stroke or transient ischemic attack related to PCI (n = 79) and a control group (n = 158), and matched them 2:1 based on a predicted probability of stroke developed from a logistic regression model.

Results PCI-stroke procedures involved the use of more catheters (median: 3 [quarter (Q) 1, Q3: 3, 4] vs. 3 [Q1, Q3: 2, 3], $p < 0.001$), greater contrast volumes (250 ml vs. 218 ml, $p = 0.006$), and larger guide caliber (median: 7-F [Q1, Q3: 6, 8] vs. 6-F [Q1, Q3: 6, 8], $p < 0.001$). The number of lesions attempted (1.7 ± 0.8 vs. 1.5 ± 0.8, $p = 0.14$) and stents placed (1.4 ± 1.2 vs. 1.2 ± 1.1, $p = 0.35$) were similar between groups, but PCI-stroke patients were more likely to have undergone rotational atherectomy (10% vs. 3%, $p = 0.029$). Overall procedural success was lower in the PCI-stroke group compared with controls (71% vs. 85%, $p = 0.017$). Evaluation of the entire PCI population revealed no difference in the rate of PCI-stroke between radial and femoral approaches (0.4% vs. 0.4%, $p = 0.78$).

Conclusions Ischemic stroke related to PCI is associated with potentially modifiable technical parameters. Careful procedural planning is warranted, particularly in patients at increased risk. (J Am Coll Cardiol Intv 2012;5:200–6) © 2012 by the American College of Cardiology Foundation

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Stroke is an infrequent but potentially devastating complication of percutaneous coronary intervention (PCI). It is associated with an in-hospital mortality rate of 20% (1–4), and in survivors of the initial event, with markedly increased long-term mortality (1). Moreover, for the patient, the possible occurrence of a major stroke may be perceived as being an outcome worse than death (2).

PCI-related mortality and adverse events other than stroke have progressively declined over the last 2 decades (3–5). However, the incidence of PCI stroke has remained unchanged at approximately 0.3% to 0.4% (1,6–8). Independent predictors include age, female sex, renal failure, and prior history of stroke or transient ischemic attack (TIA) (1,6–8). With the worsening demographic risk profile of patients being referred for PCI, and increasing procedural complexity (1), it seems unlikely that the incidence of stroke related to PCI will decline in the near future.

Approximately 90% of symptomatic strokes or TIAs related to PCI are ischemic (PCI-stroke [1,4]). The potential mechanisms underlying these events include embolization of atheroma from the aortic wall due to catheter-related trauma, embolization of thrombus or air, dissection from catheter or guidewire manipulation, and periprocedural hypotension (9–11). In support of the hypothesis of debris dislodgement during catheterization, transcranial Doppler signals have been shown to increase during passage of catheters around the aortic arch, suggestive of microembolization (12). Studies assessing the risk of catheter-related emboli report a significantly higher embolic event rate in patients with atherosclerosis compared to those without atherosclerosis (13). Furthermore, analysis of 1,000 consecutive guiding catheters removed after PCI revealed the presence of macroscopic aortic debris within the guide lumen in more than 50% of cases (14).

Whether there is a relationship between procedural factors that might influence the extent of embolization and the occurrence of PCI-stroke remains unknown. Given the devastating nature of the complication, and the inability to affect demographic risk factors, it is critically important to identify those variables that could potentially be modifiable in an attempt to reduce the risk of procedural stroke. In this retrospective, single-center study, our objective was to identify procedural factors in patients undergoing PCI who experienced an ischemic neurologic complication compared with a matched control population of those who did not.

Methods

Patient population. Patients undergoing PCI at the Mayo Clinic in Rochester, Minnesota, are prospectively followed in a registry that includes demographic, clinical, angiographic, and procedural data. Immediate and in-hospital events are recorded, and each patient is surveyed by telephone using a standardized questionnaire at 6 months, 1 year, and then annually after the procedure. Ten percent of all records are randomly audited by the supervisor for data integrity. All adverse events are confirmed by reviewing the medical records of the patients followed at our institution and by contacting the patients' physicians and reviewing the hospital records of patients followed elsewhere.

All PCIs from January 1, 1994, to March 31, 2008, were eligible for analysis. For patients with multiple PCIs during a single hospitalization, only the first PCI was included. Patients who did not consent to use of their records for research were excluded as per Minnesota state statute. There were 22,038 PCI hospitalizations of 17,689 unique patients during this period. Of those, 440 patients refused authorization of their records for research and were excluded, leaving 21,497 hospitalizations for analysis. Seventy-nine patients experiencing an in-hospital ischemic stroke or TIA relating to PCI were identified, and their demographic and angiographic variables were compared with the entire remaining nonstroke population as controls. Next, detailed medical record and angiographic review was performed to identify procedural variables from the PCI-stroke patients, which were compared with procedural variables from 158 matched control patients.

Abbreviations and Acronyms

LV = left ventricular

PCI = percutaneous coronary intervention

PCI-stroke = ischemic stroke or transient ischemic attack related to percutaneous coronary intervention

TIA = transient ischemic attack

Definitions. Ischemic stroke was defined as nonhemorrhagic stroke or TIA related to PCI in the absence of other causes. All patients suffering ischemic stroke after PCI were evaluated by a consultant neurologist. Brain imaging (computed tomography, magnetic resonance imaging, or both) excluded hemorrhage in all patients. Where there was uncertainty as to the relationship between the PCI procedure and neurologic event, adjudication was performed by an independent consultant neurologist.

The number of diseased coronary arteries was defined by the number of major arteries with at least 50% stenosis, provided at least 1 of the major arteries had at least 70% stenosis. Patients with ≥50% stenosis in the left main coronary artery were considered to have 2-vessel disease if there was right dominance and 3-vessel disease if there was left dominance. Myocardial infarction was diagnosed in the presence of at least 2 of 3 criteria: 1) typical chest pain for at least 20 min; 2) elevation of serum creatine kinase levels (or the myocardial band fraction) >2 times normal; and 3) a new Q-wave on the electrocardiogram. Severe renal dysfunction was defined as a creatinine level of >3.0 mg/dl or a history of dialysis or renal transplant. Cardiogenic shock was defined as a prolonged systolic arterial pressure <95 mm Hg, or systolic arterial pressure <110 mm Hg while on ino-