Survival and Long-Term Cardiovascular Outcomes after Carotid Endarterectomy in Patients with Chronic Renal Insufficiency

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Background: Multiple studies have evaluated the perioperative outcomes of patients with chronic renal insufficiency (CRI) undergoing carotid endarterectomy (CEA), generally indicating worse survival and cardiovascular (CV) outcomes, although not consistently and with a paucity of long-term data. The present study addresses the perioperative and long-term impact of CRI on CV events and survival after CEA.

Methods: A cohort of consecutive patients treated with CEA between January 1, 2000, and December 31, 2008, was analyzed based on medical records and Social Security Death Index. Estimated glomerular filtration rate (GFR) was assessed at baseline. Renal function was used to divide patients into 3 groups: normal (GFR $\geq$60 mL/min/1.73 m^2), moderate CRI (GFR, 30−59), and severe CRI (GFR <30). The end points were major coronary events, major cerebrovascular events (any stroke), noncardiac vascular interventions (aortic disease, carotid disease, and critical limb ischemia), and mortality. Subgroup analysis based on the presence of preoperative neurologic symptoms was also performed. Survival analysis and Cox regression models were used to assess the effect of baseline predictors.

Results: A total of 1,342 CEAs (mean age, 71.2 ± 9.2 years; 55.6% male; 35.3% symptomatic) were performed during the study period with a mean clinical follow-up of 57 months (median, 55; range, 0−155 months). Eight hundred sixty-eight (65%) patients had normal renal function, 414 (31%) had moderate CRI, and 60 (4%) had severe CRI (24 on dialysis). The combined 30-day stroke/death rates for the symptomatic and asymptomatic groups were 3.2% and 1.4% (normal renal function), 5.7% and 2.6% (moderate CRI), and 14.3% and 10.3% (severe CRI), respectively, with the differences being significant only for the severe-CRI group. At 5 years, the severe-CRI group experienced significantly more coronary events (36.9% vs. 16.3%, $P < 0.001$), more cerebrovascular events (21.6% vs. 6.3%, $P < 0.001$), and deaths (70.0% vs. 20.3%, $P < 0.001$), whereas the moderate-CRI group had no significantly different outcomes compared with the normal group, except for mortality (29.8% vs. 20.3%, $P < 0.001$). After adjusting for all risk factors, severe CRI remained predictive of coronary events (hazard ratio [HR], 2.21; 95% confidence interval [CI], 1.25−3.90; $P = 0.007$), cerebrovascular events (HR, 3.11; 95% CI, 1.44−6.74; $P = 0.004$), and mortality (HR, 4.36; 95% CI, 3.00−6.34; $P < 0.001$). Symptomatology at baseline was predictive of 5-year mortality (HR, 1.43; 95% CI, 1.14−1.81; $P = 0.002$). The need for noncardiac vascular interventions was equally distributed among all the groups.

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Conclusions: Severe but not moderate CRI is associated with poor perioperative outcomes and is an independent predictor of CV events and death at 5 years after CEA. The decision to perform CEA in symptomatic and asymptomatic patients with severe CRI should be individualized given the poor reported outcomes.

INTRODUCTION

Multiple studies have evaluated the perioperative outcomes of patients with chronic renal insufficiency (CRI) undergoing carotid endarterectomy (CEA), the majority indicating poor survival and cardiovascular (CV) outcomes.[1−12] Not all CRI patients are the same though, and stratification of CRI has yielded inconsistent outcomes, as definitions of ''mild,'' ''moderate,'' or ''severe'' vary according to the indicator used: plasma levels of creatinine with various cutoff values or creatinine clearance measured either with the Cockcroft−Gault or the Modification of Diet in Renal Disease (MDRD) method. Creatinine level seems to be a late and insensitive marker of renal insufficiency and can remain <2.0 mg/dL, despite a significant reduction of the glomerular filtration rate (GFR) to as low as 15 mL/min/1.73 m^2.[3] For this reason, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines recommend the use of GFR as the reliable indicator of CRI. The discrepancy of CEA outcomes has been demonstrated based on the measure of CRI.[4] When using serum creatinine alone, there was no difference in overall stroke and major adverse event rates among normal renal function, moderate-CRI, and severe-CRI groups. However, when renal function was examined using GFR, there was a statistically significant higher perioperative stroke rate and a trend toward a higher rate of major adverse events for the moderate- and/or severe-CRI groups. However, very few studies have analyzed the perioperative outcomes of CEA stratified by GFR,[1−4] and there is paucity of data looking at the long-term outcomes.[3,13] The present study addresses the perioperative impact and the long-term impact of CRI as stratified by GFR on CV events, major vascular interventions, and survival after CEA, targeting to guide physician expectations and patient selection.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board at the University of Pittsburgh.

Study Design

Consecutive individuals who underwent CEA at the Division of Vascular Surgery of the University of Pittsburgh Medical Center between January 1, 2000, and December 31, 2008, were identified by the Current Procedural Terminology code 35301. The records were reviewed for demographics, baseline risk factors, carotid imaging, indications for intervention, intraprocedural data, periprocedural complications, and long-term outcomes. The Social Security Death Index was used to record death dates. Patients who underwent concomitant carotid procedures (e.g., carotid to carotid bypass, carotid thrombectomy) were excluded from the study.

For the purpose of our study, patients were categorized in to 3 groups depending on their renal function as indicated by the estimated GFR at the time of surgery: normal (GFR ≥60 mL/min/1.73 m^2), moderate (GFR 30−59), and severe (GFR <30).

The end points were major coronary events, major cerebrovascular events, noncardiac major vascular interventions, and mortality. Subgroup analyses according to preoperative indication for surgery and symptom status were performed.

Definitions

Carotid stenosis was considered symptomatic if the patient had experienced neurologic ischemic events, such as a transient ischemic attack (lasting <24 hr), amaurosis fugax, or stroke in the 6 months before CEA.

Carotid stenosis was evaluated predominately by carotid duplex. These studies were performed by registered vascular technologists in a fully accredited vascular laboratory and reviewed by a vascular surgeon. The degree of internal carotid artery (ICA) stenosis was determined on the basis of velocity criteria and ICA−Common Carotid Artery (CCA) ratio previously validated at our institution: none or mild <50% (ICA/CCA peak systolic velocity (PSV) 0.1−1.9; PSV <125; end diastolic velocity <140), moderate 50−69% (ICA/CCA PSV 2.0−4.0), and severe 70−99% (ICA/CCA PSV >4; PSV >230).

Estimation of GFR was performed at the time of surgery for all patients and calculated using the MDRD formula and expressed in milliliter per minute per 1.73 m^2.[14] The cutoff value for CRI based on GFR was adapted from the Kidney Foundation.[15] A GFR ≥60 mL/min/1.73 m^2 was considered normal or mildly reduced kidney function (stage 1 or 2), a