Carotid artery stenting in octogenarians is associated with increased adverse outcomes

Stephen F. Stanziale, MD,⁎ Luke K. Marone, MD,⁎ Tamer N. Boules, MD,⁎ Judith A. Brimmeier, BSN,⁎ Katherine Hill, BSN,⁎ Michel S. Makaroun, MD,⁎ and Mark H. Wholey, MD,⁎ Pittsburgh, Penn

Background: Carotid artery stenting is an increasingly common endovascular treatment of carotid artery stenosis advocated in high-risk patients despite reports of increased adverse periprocedural outcomes in patients aged >80 years. We sought to evaluate our single institution experience with octogenarians and whether they have an increased incidence of major complications with carotid artery stenting.

Methods: Three hundred eighty-six patients, including 260 patients from 10 regulatory trials, who underwent carotid artery stenting between June 1996 and March 2004 for symptomatic or asymptomatic carotid stenosis were reviewed from a prospectively maintained database. Periprocedural (≤30 days after carotid artery stenting) cerebrovascular accident, transient ischemic attack, myocardial infarction, and death outcomes were compared between 87 octogenarians and 295 nonoctogenarians. Univariate and multivariate analysis was performed for confounding factors. Kaplan-Meier analysis of stroke and death outcomes was performed for a 1-year follow-up.

Results: All adverse outcomes were significantly higher in octogenarians compared with younger patients: 30-day stroke rate, 8.0% vs 2.7% (P = .02); 30-day stroke, myocardial infarction, or death, 9.2% vs 3.4% (P = .02). Cohorts were similar in terms of gender, comorbidities, antiplatelet medications, symptomatic status, and use of cerebral protection. Octogenarians had a greater incidence of contralateral internal carotid artery occlusion (26% vs 12%, P = .001), atrial fibrillation (21% vs 8%, P = .001), and congestive heart failure (28% vs 15%, P = .007), but a lower incidence of hypercholesterolemia (53% vs 72%, P = .001) and active smoking (8% vs 24%, P = .001). Multivariate analysis of 30-day major adverse outcomes demonstrated an association between age ≥80 and adverse outcome (odds ratio, 2.85; P = .043) as well as a protective effect of the preprocedural use of aspirin (odds ratio, 0.30, P = .027). At 1-year follow-up, only 75% of octogenarians and 87% of nonoctogenarians were free from stroke, myocardial infarction, or death (P = 0.005, Kaplan-Meier analysis).

Conclusions: Octogenarians undergoing carotid artery stenting are at higher risk than nonoctogenarians for periprocedural complications, including neurologic events and death. Major event-free survival at 1 year is also significantly better in nonoctogenarians. These risks should be weighed when considering carotid stenting in elderly patients. (J Vasc Surg 2006;43:297-304.)

Prospective, randomized trials have demonstrated stroke prevention benefit to carotid endarterectomy plus medical therapy versus medical therapy alone in the management of patients with carotid artery stenosis.1,2 Specific exclusion criteria limited entry into two major clinical trials, North American Symptomatic Carotid Endarterectomy Trial (NASCET) and Asymptomatic Carotid Atherosclerosis Study (ACAS), to patients aged <80 years because of the putative high risk of endarterectomy in octogenarians. Several nonrandomized studies have since demonstrated the comparable safety of carotid endarterectomy in octogenarians.3-10 To date, the efficacy of carotid endarterectomy in octogenarians has not been addressed in a randomized trial.

Carotid artery stenting, an increasingly common endovascular procedure, shows promise as an alternative therapy in the treatment of carotid artery stenosis.11-17 The role of carotid artery stenting in octogenarians is similarly controversial. In an early carotid artery stenting series, octogenarians had a greater incidence of periprocedural stroke (16%) than did younger patients (5.4%). The authors concluded that the greatest risk factor for 30-day stroke was age >80 years.12 Advancements such as cerebral protection devices and flexible, crush-resistant nitinol stents were not available at the time of this study. More recent trials of high-risk patients that included up to 20% octogenarians show good clinical results supporting that carotid artery stenting is not inferior to carotid endarterectomy.18

In the past year, Hobson et al19 published periprocedural results of 749 patients from the lead-in phase of the Carotid Revascularization Endarterectomy versus Stent Trial (CREST). Octogenarians had a markedly elevated 30-day periprocedural stroke rate of 12.1% vs 4.0% in nonoctogenarians. The rate for stroke or death was also higher for older patients (12.1% vs 4.4%). This significant difference was not mediated by symptomatic status, anatomic factors, protective devices, or degree of stenosis.19 As a result of these findings, octogenarians have been excluded from further enrollment in the CREST trial, which used a single stent and protection device system.

Our goal in this study was to evaluate our prospectively maintained database of carotid stent patients to determine...
if octogenarian status affects periprocedural as well as 1-year outcomes.

METHODS

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

Definitions. Stroke or cerebrovascular accident (CVA) was defined as a neurologic deficit lasting at least 24 hours. No distinction was made between minor strokes and major strokes, and all strokes were included. Transient ischemic attack (TIA) was defined as focal retinal or cerebral event from which there was no neurologic sequela after 24 hours. Death was qualified as either a direct sequelae of stroke or due to another etiology.

Patients. From June 1996 to March 2004, 386 patients were scheduled for internal carotid artery stenting. Neurologists evaluated the patients before the carotid stenting procedures. Patients were considered symptomatic if they had TIAs, amaurosis fugax, or strokes with clinically-correlated, lateralizing symptoms ≤60 days preceding the carotid intervention. Outside of this window, patients were considered to be asymptomatic.

Carotid artery stent procedure. Patients underwent carotid stenting in the angiography suite by one of three interventionalists. Procedures were performed under local anesthesia with intravenous sedation. Cerebral angiography was performed before the procedure, and the percent stenosis was determined by the NASCET method.1 Symptomatic patients undergoing stenting for ≥50% stenosis, and asymptomatic patients undergoing stenting for ≥80% stenosis.

During the first year of patient accrual, patients were treated preprocedurally with ticlopidine (250 mg twice a day). In the ensuing years of the study, patients received a preprocedural 300-mg loading dose of clopidogrel and a maintenance, postprocedural dose of 75 mg/day for 3 months. Aspirin was initiated only if indicated by the regulatory trial in which the patient was enrolled; otherwise, preprocedural aspirin was prescribed at the discretion of the interventionalist. No changes were made to a patient’s regimen if he or she were already taking aspirin. During stenting, patients received anticoagulation with heparin to a goal activated clotting time of ≥275 seconds.

The stent systems were inserted according to the regulatory trial protocol in which the patients were enrolled, including Precise (Cordis Endovascular, Miami Lakes, Fla), Smart (Cordis Endovascular), NextStent (EndoTex Interventional Systems, Cupertino, Calif), Accunet (Greenville, NC), Wallstent (Boston Scientific, Natick, Mass), and EndoTex (Cupertino, Calif) stents. Embolic protection devices were also used according to the regulatory trial protocol and included Angioguard (Cordis Endovascular), Accunet (Guidant, Indianapolis, Ind), PercuSurge (Medtronic, Minneapolis, Minn), and Epi (Boston Scientific) devices. Patients not participating in a trial had stents and protection devices inserted at the discretion of the interventionalist. Patients who received balloon-expandable stents were excluded from this study.

Data collection. All patients were entered into a prospective database, and 68% were entered into one of 10 different regulatory trials. Comorbidities and current medications were recorded. All periprocedural events were recorded. Stroke scales were not uniformly applied for patients not involved in regulatory trials. Major adverse events included stroke, myocardial infarction, and death. TIAs were also recorded. Minor adverse events included groin site complications, hypotension requiring postprocedural vasopressors, and urinary retention. For the complete listing, see Results section.

Statistical analysis. Statistical analysis between octogenarians and nonoctogenarians was performed by using the χ² statistic. When χ² was not appropriate for less frequent occurrences, Fisher’s exact test was performed. The Wilcoxon rank sum test was used to compare mean time of follow-up. The Cochran-Mantel-Haenszel trend test was used to examine age groupings for significant trends. Any value expressed as P < .05 was considered significant.

The association between octogenarian status and the composite 30-day outcome of stroke, myocardial infarction, or death was examined by using logistic regression. The multivariable model included factors associated with outcomes on univariate analysis as well as clinically relevant variables believed to be associated with the outcome based on prior research.

RESULTS

Follow-up. Mean length of hospital stay (± standard deviation) was similar between patients aged <80 and ≥80 years, 1.8 ± 2.0 and 2.2 ± 2.7 days, respectively (P = NS). Mean length of follow-up for all patients was 415 days. Mean follow-up for patients <80 years was 431 days (maximum, 1327 days), and for patients ≥80 years, it was 361 days (maximum, 1172 days) (P = .036).

Baseline characteristics. In four (1.0%) of the 386 patients, carotid stenting was aborted before stent insertion owing to technical complexity; none of these four developed subsequent morbidity.

Carotid artery stents were inserted in 382 patients with asymptomatic and symptomatic carotid stenosis. Patient clinical characteristics are delineated in Table I. Octogenarians were an average of 14 years older than nonoctogenarians. Men comprised 60% of both cohorts. Comorbidities were similar except for an increased incidence of atrial fibrillation (21% vs 8%, P = .001) and congestive heart failure (28% vs 15%, P = .007) in octogenarians and a decreased incidence of hypercholesterolemia (53% vs 72%, P = .001) and active smoking (8% vs 24%, P = .001) in octogenarians.

Asymptomatic carotid artery stenosis was present in 74% of patients <80 years old, and 71% of patients ≥80 years were asymptomatic (P = NS). Contralateral internal carotid artery occlusion was more common in octogenarians (26% vs 12%, P = .001) but was not significantly associated with outcome by univariate analysis (odds ratio [OR], 0.32, P = .28). Cerebral protection was used in 62% of octogenarians and 52% of nonoctogenarians (P = .093).
Table I. Patient characteristics before carotid stenting

<table>
<thead>
<tr>
<th></th>
<th>Nonoctogenarians (n = 295) (%)</th>
<th>Octogenarians (n = 87) (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>69 ± 7.6</td>
<td>83 ± 2.7</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>59.7</td>
<td>59.8</td>
<td>.985</td>
</tr>
<tr>
<td>CAD/MI</td>
<td>64.7</td>
<td>65.5</td>
<td>.895</td>
</tr>
<tr>
<td>CABG</td>
<td>86.3</td>
<td>37.9</td>
<td>.778</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>8.1</td>
<td>20.7</td>
<td>.001</td>
</tr>
<tr>
<td>CHF</td>
<td>14.9</td>
<td>27.6</td>
<td>.007</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>71.5</td>
<td>52.9</td>
<td>.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>81.4</td>
<td>80.5</td>
<td>.626</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>34.2</td>
<td>25.3</td>
<td>.116</td>
</tr>
<tr>
<td>Smoking history</td>
<td>80.3</td>
<td>73.6</td>
<td>.174</td>
</tr>
<tr>
<td>Active smoking</td>
<td>23.7</td>
<td>8.0</td>
<td>.001</td>
</tr>
<tr>
<td>Baseline creatinine</td>
<td>1.2 mg/dL</td>
<td>1.3 mg/dL</td>
<td>.225</td>
</tr>
<tr>
<td>History of TIA</td>
<td>39</td>
<td>38</td>
<td>.860</td>
</tr>
<tr>
<td>History of CVA</td>
<td>28</td>
<td>21</td>
<td>.205</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>74</td>
<td>71</td>
<td>.626</td>
</tr>
<tr>
<td>Contralateral occlusion</td>
<td>12</td>
<td>26</td>
<td>.001</td>
</tr>
<tr>
<td>Cerebral protection</td>
<td>52</td>
<td>62</td>
<td>.093</td>
</tr>
</tbody>
</table>

CAD, Coronary artery disease; MI, myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack; CTA, cerebrovascular accident.

Table II. Medications of carotid stent patients

<table>
<thead>
<tr>
<th></th>
<th>Nonoctogenarians (%)</th>
<th>Octogenarians (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprocedure</td>
<td>(n = 295)</td>
<td>(n = 87)</td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>82.4</td>
<td>85.1</td>
<td>.588</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>80.3</td>
<td>88.1</td>
<td>.320</td>
</tr>
<tr>
<td>Anticholesterol</td>
<td>58.3</td>
<td>33.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nitrites</td>
<td>23.1</td>
<td>16.1</td>
<td>.165</td>
</tr>
<tr>
<td>Calcium-channel blockers</td>
<td>33.2</td>
<td>25.3</td>
<td>.161</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>40.3</td>
<td>28.7</td>
<td>.05</td>
</tr>
<tr>
<td>At follow-up</td>
<td>(n = 159)</td>
<td>(n = 48)</td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>79.6</td>
<td>83.3</td>
<td>.582</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>39.7</td>
<td>43.8</td>
<td>.622</td>
</tr>
</tbody>
</table>

The use of cerebral protection became commonplace by July 2000, approximately the midpoint of patient accrual.

Medication histories before carotid stenting were not significantly different between the two cohorts, including use of the antplatelet agents aspirin and clopidogrel (Table II). Use of statin anticholesterol medications was more prevalent in patients <80 years old (58% vs 33%, P < .001), paralleling the greater incidence of hypercholesterolemia in this cohort. Similar percentages of patients took antplatelet medications recorded at the last follow-up (Table II).

Periprocedural neurologic events and mortality. Octogenarians had more major adverse events ≥30 days of the stenting procedure than younger patients (Table III). The incidence of stroke was 2.7% in patients <80 years old and 8.0% in those ≥80 (P = .024). Periprocedural death mirrored this disparity: 1.0% for nonoctogenarians vs 5.7% for octogenarians (P = .007). By grouping major adverse events (stroke, myocardial infarction, or death), the incidence was 3.4% vs 9.2% in patients <80 years old vs those ≥80 (P = .024).

Table III. Major adverse events ≥30 days of stent procedure

<table>
<thead>
<tr>
<th></th>
<th>Nonoctogenarians (n = 295) (%)</th>
<th>Octogenarians (n = 87) (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVA</td>
<td>2.7</td>
<td>8.0</td>
<td>.024</td>
</tr>
<tr>
<td>TIA</td>
<td>3.7</td>
<td>4.6</td>
<td>.714</td>
</tr>
<tr>
<td>MI</td>
<td>0.7</td>
<td>1.1</td>
<td>.661</td>
</tr>
<tr>
<td>Death</td>
<td>1.0</td>
<td>5.7</td>
<td>.007</td>
</tr>
<tr>
<td>CVA or MI or death</td>
<td>3.4</td>
<td>9.2</td>
<td>.024</td>
</tr>
</tbody>
</table>

TIA, Transient ischemic attack; CVA, cerebrovascular accident; MI, myocardial infarction.

No significant difference was noted in the overall 30-day stroke rate between symptomatic (4.9%) and asymptomatic (3.2%) patients (P = .44). Incidence of TIA ≥30 days was also not significantly different between symptomatic (3.9%) and asymptomatic (3.9%) patients (P = .99).

There was a significant trend even below the 80-year-old threshold toward increasing adverse periprocedural events with advancing age. The incidence of stroke in patients <70, 70 to 80, and ≥80 years old was 2.3%, 3.1%, and 8.0%, respectively (P = .04 for trend). The incidence of stroke, myocardial infarction, or death in patients <70, 70 to 80, and ≥80 years old was 2.3%, 4.3%, and 9.2%, respectively (P = .02, for trend).

In terms of timing of 30-day strokes among nonoctogenarians, seven of the eight total strokes occurred ≤24 hours of carotid artery stenting. One patient had a stroke on postprocedure day 23. In octogenarians, six of the seven total strokes occurred ≤24 hours of carotid artery stenting. One patient had a stroke on postprocedure day 1.

In terms of timing of 30-day TIs among nonoctogenarians, 10 of the 11 TIs occurred within the first 24 hours postprocedure. The additional TIAs occurred on postprocedure day 1. In octogenarians, all four of the TIs occurred within the first 24 hours postprocedure.

There was no significant difference between cohorts in any minor periprocedural complications. The most common minor adverse event was vasopressor requirement, occurring in 14.9% of nonoctogenarians and 10.8% of octogenarians (P = .30); 2.3% and 5.7%, respectively, had a vasopressor requirement that prolonged hospital stay (P = .118). Other complications similar in both cohorts included groin hematomas and infections, urinary retention, gastrointestinal bleeding, epistaxis, and arrhythmias.

Late survival and freedom from adverse events. One-year Kaplan-Meier curves are shown in the Fig. Composite survival (Fig. A) is significantly lower at 1 year for octogenarians (81% vs 93%; P = .003): 14 of 87 octogenarians died within the first postprocedural year. Freedom from stroke or death is shown in Fig. B. Only 76% of octogenarians had stroke-free survival by 1 year. Fig. C demonstrates the five additional strokes in nonoctogenarians >30 days but ≤1 year, producing an overall 95.5%
freedom from stroke; three additional strokes occurred in octogenarians, producing an overall 88.7% freedom from stroke. With myocardial infarction taken into account (Fig, D), only 75% of octogenarians are free from major adverse events at 1 year. This is a considerably worse 1-year outcome than the 87% seen in nonoctogenarians (P = .005). Importantly, only 59% of nonoctogenarians and 45% of octogenarians were available for follow-up at 1 year. This corresponds to 44% of patients overall lost to follow-up by 1 year.

Univariate and multivariable analyses. Univariate analysis was used to investigate 26 demographic, clinical, and procedural variables for association with 30-day major adverse events (stroke, myocardial infarction, and death). Only two had statistically significant association: octogenarian status and preprocedural aspirin use (see Table IV). Octogenarian status was associated with increased periprocedural events, with an OR of 2.89 (P = .005). Preprocedural use of aspirin had a protective effect against major adverse events (OR, 0.23; P = .004). Interestingly, congestive heart failure (OR, 2.44) had a near-significant association with adverse outcome (P = .086), and cerebral protection (OR, 0.40) had a near-significant reduction of risk (P = .077).

Multivariate analysis was performed to evaluate for a confounding effect, including individual variables with the greatest association to outcome in a model with octogenarian status (Table V). The final multivariate model indicated that octogenarian status (P = .043) was associated with major adverse periprocedural events. Preprocedural use of aspirin (P = .027) was protective of major adverse events. The goodness of fit, P = .92, indicates that the model fits the data reasonably well.

DISCUSSION

Our data indicate that carotid stenting in octogenarians is associated with a high risk of adverse events, both at 30 days and 1 year, and should be cautiously considered.

The influence of advanced patient age on the safety and efficacy of intervention for carotid artery stenosis is controversial. Multiple randomized clinical trials have demonstrated that carotid endarterectomy reduces long-term stroke risk in patients with symptomatic and asymptomatic carotid stenosis, but none have included patients ≥80 years.
old. A few nonrandomized studies have asserted that age has a negative impact on outcome after carotid endarterectomy, but many other reports maintain that age has no effect on early short-term outcomes. Controversy regarding the effect of age on outcome surrounds carotid artery stenting as well. Chastain et al in a carotid stenting series of 158 patients published in 1999, reported a major adverse event rate of 25% in octogenarians vs 8.2% in younger patients. This group also reported a major adverse event rate of 25% in octogenarians vs 8.2% in younger patients. This group also reported a major adverse event rate of 25% in octogenarians vs 8.2% in younger patients. That 20% of octogenarians had fatal and nonfatal strokes by 80 years old. A few nonrandomized studies have asserted that age has a negative impact on outcome after carotid endarterectomy, but many other reports maintain that age has no effect on early short-term outcomes.

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First, octogenarians had twice the incidence of congestive heart failure (CHF) than nonoctogenarians (27.6% vs 14.9%, \( P = .007 \)). CHF in octogenarians had a confounding effect on the association of age with outcome, although not quite significant by univariate analysis (OR, 2.44; \( P = .086 \)) or by multivariate analysis (OR, 2.09; \( P = .17 \)). Previously, in a survey of 1160 randomly selected carotid endarterectomies at 12 centers, CHF was shown to be associated with a three times greater incidence of stroke in the periprocedural period.\(^{28}\)

Second, more than twice as many octogenarians had contralateral internal carotid artery occlusion than nonoctogenarians, which one might expect to be associated with greater risk. Although the OR of 0.32 associated with contralateral occlusion was not significant (\( P = .28 \)), it unexpectedly suggested a protective effect. In previously published work, contralateral occlusion had been considered a high-risk criterion.\(^{25}\) Ultimately, the effect of contralateral occlusion has not been elucidated, occasionally associated with a higher risk of periprocedural events in some studies\(^{2,29}\) but not in others.\(^{30}\)

One limitation of our study is the high number of patients lost to follow-up. Only 173 (59%) of 295 nonoctogenarians and 39 (45%) of 87 octogenarians were available at 1 year. This was largely owing to failure to return, no physician follow-up, or both. This, however, should not affect the early 30-days results and should only decrease the confidence in our 1-year comparisons. By 2 years, 86% of patients were lost to follow-up, and we do not report the analysis of these patients.

Another issue may be raised over the long 8-year accrual span of this study, during which many technical advances in carotid stenting occurred. For instance, many of the patients were stented without cerebral protection, a technical development during the latter half of the study period presumed to decrease stroke rates.\(^{31}\) Some, in fact, suggest that octogenarians may derive greater benefit in terms of freedom from stroke with use of cerebral protection,\(^{19,32}\) potentially accounting for the higher stroke rates seen in early studies of octogenarians.

This should not influence our results, however, as worse outcomes in the octogenarian group were noted despite a higher utilization of cerebral protection, a technical development during the latter half of the study period presumed to decrease stroke rates.\(^{31}\) Some, in fact, suggest that octogenarians may derive greater benefit in terms of freedom from stroke with use of cerebral protection,\(^{19,32}\) this has become our routine since 2000 and is consistent with others performing carotid artery stenting.

Of course, randomized clinical data are necessary to confirm our findings and to determine the appropriateness of carotid artery stenting in octogenarians. Caution should be the rule in stenting octogenarians, however, especially in asymptomatic patients, as both their short- and long-term outcomes do not appear to be very encouraging. Ultimately, determining the proper population to benefit from carotid stenting is paramount as technology emerges and progresses.
much. As Dr Parodi showed yesterday, we still have a significant risk
among these octogenarians. In CREST, we found that anatomical tortu-
sity of the cervical carotid artery was important. These patients
without making us feel nervous. We used to joke that
procedure.
As Dr Parodi showed yesterday, we still have a significant risk of
intracranial complication during the angioplasty and stent pro-
McCrorry DC, Goldstein LB, Samsa GP, Oddone EZ, Landsman PB,
Angiogram study done to 235 Korean patients with extracranial carotid disease showed 33.5% anatomically significant and also 11.2% hemodynamically significant intracranial, either as cerebral and/or cerebellar lesions as incidental findings. Hemodynamically significant lesions seem to affect the clinical outcome with increasing morbidity and mortality in our series. Putting this data together, I began to wonder how much this incidentally found intracranial lesion, which is combined with extracranial carotid lesion, would affect overall outcome of the carotid surgery among ever-increasing octogenarians, especially among the Asian population. I wish somebody would give a serious look to this fact, especially among the candidates of endovascular management.

As Dr Parodi showed yesterday, we still have a significant risk of intracranial complication during the angioplasty and stent pro-
and we do not have a foolproof brain protection device. The more we committed to this new therapy without knowing enough, like the endarterectomy, the more we were dragged into

such unknown territory like multiple intracranial lesions. We really have to take a second look at this issue in new era of endovascular treatment as we did for the endarterectomy, before we somehow wind up having trouble such as negligence. We used to joke that


DISCUSSION

Dr Byung-Boon Lee (Reston, Va). I congratulate you for
such unique data that you shared with us. I enjoyed them enormously but with some concern. Have you ever considered the combined intracranial, either intracerebral or intracerebellar, vascular lesion as a potential risk factor for this octogenarian group in particular?

Dr Luke K. Marone. We do not have the data on the percentage of intracranial or intracerebral lesions exhibited by each cohort.

Dr Lee. My concern is the unclear role and significance of intracranial lesions among the carotid surgery candidates in Korea. We confirmed a higher incidence and prevalence of intracranial lesions among carotid candidates in Korea through angiographic assessment. Four-vascular angiostudy done to 235 Korean patients with extracranial carotid disease showed 33.5% anatomically significant and also 11.2% hemodynamically significant intracranial, either as cerebral and/or cerebellar lesions as incidental findings. Hemodynamically significant lesions seem to affect the clinical outcome with increasing morbidity and mortality in our series. Putting this data together, I began to wonder how much this incidentally found intracranial lesion, which is combined with extracranial carotid lesion, would affect overall outcome of the carotid surgery among ever-increasing octogenarians, especially among the Asian population. I wish somebody would give a serious look to this fact, especially among the candidates of endovascular management.

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Dr Marone. We constructed many multivariable analyses and models. In each model, age always washed out as a significant predictor of adverse event despite how we formulated the models. We did not find any significant difference in how the octogenarians fared during the procedure from a vasopressor requirement or in the development of intraprocedural arrhythmias requiring therapy, so I am not sure if those applied to this patient cohort, or if those confounding variables applied. I actually did not run them because they were not significant in the multivariate models and they did not trend toward significance at all.

Dr M. Ashraf Mansour (Grand Rapids, Mich). You report 7 strokes in the younger group and 8 in the older group. Did you review the stroke patients and see if all of them had embolic protection devices or not? If an embolic protection device was used, was there a problem retrieving the filter? Was there a problem deploying the stent? Were more stents used in those older patients?

Dr Marone. In looking at those stroke patients in particular, there was no significant difference in their utilization of protection devices at all.

Dr Christopher Kwolek (Boston, Mass). It has been our experience that in this elderly population there does seem to be a higher incidence of extreme calcification, tortuosity, and this more difficult arch anatomy. We also know that there is a learning curve with carotid angioplasty and stenting. Perhaps that learning curve is not just due to improving technical skills, but also in learning which patients to back out on. Had you thought about going back and quantitating the degree of tortuosity and disease in the arch vessels and seeing if there was a relationship with strokes or poor outcomes?

Dr Marone. We actually have not, as of yet, gone back and reviewed the angiograms to assess for a particular tortuosity in the octogenarians as opposed to the nonoctogenarian cohort. That work could be done down the line.

Dr Richard Schutzer (Brooklyn, NY). I apologize if I missed this, but was there any difference on the indications for the procedure between the two groups?

Dr Marone. No, there was no difference in the symptom status between the two groups.

Dr Takao Ohki (Bronx, NY). I want to challenge your conclusion in which you said a randomized trial is needed. We already have the Rubin series, the CREST series, and your series, all of which showed a three- to fourfold increase in neurological complication in octogenarians. If you do a meta-analysis, I believe that you would have a very powerful suggestion that octogenarians do not do well following stenting. Do you really think it is ethical to randomize octogenarians in the presence of such convincing data?

Dr Marone. I think that is a very good comment, and I think you are right. It would be probably impossible, based on all these data that are accumulating, to randomize asymptomatic patients. However, I think the symptomatic octogenarian may be a different story and we may be able to put together a trial randomizing symptomatic octogenarians.

Dr Enrico Ascher (Brooklyn, NY). This group of patients between 75 and 80 years old, I am a little bit concerned about this subgroup, because already in the septuagenarians you have got an over 5% stroke rate. And most of your patients were asymptomatic. Do you think that if you analyze a subset of patients between 75 and 80, would there be a little bit higher stroke rate that would prohibit you from doing angioplasties in these patients, particularly if they are asymptomatic?

Dr Marone. We actually have not done that entire subgroup analysis. The analysis you saw was a trend analysis, which revealed a trend of increasing rate with advancing age. But that analysis could be done in the future.

Dr Ascher. It should be done.

Dr Juan Parodi (St. Louis, Mo). We have done cerebral functional research studies in patients undergoing carotid artery stenting, and we used transcranial Doppler routinely; what we found is that older patients have in general a very poor cerebral functional reserve, and using transcranial Doppler we detected showers of particles in every single patient either using no protection or filters. Our hypothesis is that patients with low cerebral vascular reserve have less tolerance to the challenge of cerebral emboli. Using flow reversal as a method for cerebral protection prevents emboli effectively, and in our initial 200 patients incidence of stroke in patients older than 80 (36 patients) was nil. My question: Have you done any cerebral functional studies or have you used transcranial Doppler in these patients?

Dr Marone. As of yet we have not used transcranial Doppler to evaluate for intracerebral emboli during the procedures.