Asymptomatic Carotid Artery Bruits in a Population of Elderly Adults With Isolated Systolic Hypertension

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SUMMARY  A sample of 99 elderly (over age sixty) adults with isolated systolic hypertension were examined for cervical arterial bruits and systolic blood pressure measurements were taken in upper and lower extremities. The ratio of ankle to arm blood pressure (ankle/arm index) was used as a measure of the degree of obstruction in peripheral arterial circulation. The prevalence of bruit (asymptomatic in all cases) was high, with 24 bruits detected in 19 (19%) participants. This high prevalence of bruits is thought to be due to the blood pressure characteristics of this population. Those with bruit were found to have a 3.9 times greater chance of having an abnormal ankle/arm index. The relationship remained statistically significant even after controlling for the effects of age and smoking. These findings add further evidence to the hypothesis that asymptomatic cervical bruits are an indication of systemic vascular disease.

THE RISK OF STROKE for persons with asymptomatic carotid bruit continues to be a very controversial topic. Two recent prospective studies have provided data suggesting that asymptomatic carotid bruits increase the risk of stroke between 1.6 and 7.5 fold.1 2 However, correlation between location of the carotid bruit and type of subsequent stroke was poor. Myocardial infarction also occurred more frequently and to a degree similar to that observed for stroke. In general, mortality, particularly cardiovascular mortality, was notably higher in persons with asymptomatic carotid bruit.

The frequency of carotid bruits has been found to be more than twice as high in persons with systolic hypertension as in normals.2 High systolic blood pressure has also been associated with other forms of vascular disease, including peripheral arterial stenosis.3 Little information however has been reported about the relationship between carotid bruits and peripheral arterial stenosis. The current research was designed to investigate this relationship in a group of 109 elderly (over age sixty) men and women with isolated systolic hypertension.

Methods

The subjects involved in the current investigation were participants enrolled in the Systolic Hypertension in the Elderly Program (SHEP), a multi-center clinical trial designed to test the efficacy of treatment of systolic hypertension in an elderly population. Screening for this study took place at shopping malls, retirement centers, churches, senior citizens' clubs and other locations where predominantly healthy elderly adults could be found. Qualifications for entry into the study included an age of 60 or above, systolic pressure greater than or equal to 160 and diastolic blood pressure less than 90. Exclusions for entry were as follows:

1) Current treatment with antihypertensive medications.
2) Other current medications including insulin, anticoagulants or beta blockers.
3) Congestive heart failure not adequately controlled with digitalis.
4) Alcoholism — history of treatment for alcoholism, history of six or more drinks per day or liver disease.
5) Malignant cancer or other life-threatening disease.
6) Chronic obstructive pulmonary disease such that metoprolol was contraindicated in the judgment of the clinic physician.
7) Peripheral vascular disease and evidence of tissue injury or loss of an extremity.
8) Known sensitivity to Chlorthalidone, Reserpine, Metoprolol or Hydralazine.
9) Carotid bruit and history of transient ischemic attack (TIA).
10) History of accelerated or malignant hypertension.
11) Pacemaker.

Those with symptomatic bruit were excluded, as well as those with far advanced peripheral vascular disease (e.g. requiring amputation). In summary, the study population was a relatively healthy group of elderly people with isolated systolic hypertension.

Ninety-nine participants were examined for carotid bruits, and ankle and arm blood pressures measured. Nine participants were unavailable for examination due to death (one participant died of cancer), illness or disinterest in the program. One additional patient was excluded because an accurate A/A index could not be obtained. These participants are thought to be random and should not have biased the final population sample. A full medical history was obtained including history of cigarette smoking, intermittent claudication and angina. History of angina was determined by the Rose Questionnaire.4 Serum cholesterol values were measured during the baseline SHEP visit.

Carotid bruits were detected by auscultation of the supraclavicular, bifurcation and suprabifurcation areas of the carotid arteries with the participants in a supine position. Location and quality of any bruits were recorded. Cardiac auscultation ruled out murmurs referred to the carotid area.
TABLE 2  Prevalence of Asymptomatic Carotid Bruit and Abnormal Ankle/arm Index by Age and Sex

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Men</th>
<th></th>
<th></th>
<th>Women</th>
<th></th>
<th></th>
<th>Combined</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of</td>
<td>% with</td>
<td>% with</td>
<td>No. of</td>
<td>% with</td>
<td>% with</td>
<td>No. of</td>
<td>% with</td>
</tr>
<tr>
<td></td>
<td>participants</td>
<td>bruit</td>
<td>abn. A/A</td>
<td>participants</td>
<td>bruit</td>
<td>abn. A/A</td>
<td>participants</td>
<td>bruit</td>
</tr>
<tr>
<td>60-69</td>
<td>19</td>
<td>26.3 (5)</td>
<td>21.0 (4)</td>
<td>15</td>
<td>13.3 (2)</td>
<td>6.6 (1)</td>
<td>34</td>
<td>20.6 (7)</td>
</tr>
<tr>
<td>70-79</td>
<td>16</td>
<td>18.8 (3)</td>
<td>6.3 (1)</td>
<td>40</td>
<td>20.0 (8)</td>
<td>7.5 (3)</td>
<td>56</td>
<td>19.6 (11)</td>
</tr>
<tr>
<td>80+</td>
<td>2</td>
<td>0.0 (0)</td>
<td>0.0 (0)</td>
<td>7</td>
<td>14.3 (1)</td>
<td>42.9 (3)</td>
<td>9</td>
<td>11.1 (1)</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>21.6 (8)</td>
<td>13.5 (5)</td>
<td>62</td>
<td>17.7 (11)</td>
<td>11.3 (7)</td>
<td>99</td>
<td>19.2 (19)</td>
</tr>
</tbody>
</table>

The ratio of ankle to arm blood pressure known as the ankle/arm index (A/A index) was chosen as a measure of peripheral vascular disease. The method has been proven to be reliable for detecting the presence of peripheral arterial stenosis or occlusion, and also been used successfully in an elderly population.

After the participants had rested for at least five minutes in a supine position, ankle and arm systolic blood pressures were taken with an ultrasonic technique using a Doplette 10 doppler. Arm systolic pressures were measured in rapid succession to ankle pressures using a random zero muddler. Two sets of ankle and arm pressures were taken to yield two separate A/A indexes which were averaged. An A/A index of less than 95% was considered indicative of peripheral vascular disease of the lower extremity.

Reliability of A/A Index and Carotid Bruit

The reliability of the measurements of A/A index was tested on ten student volunteers prior to the study. The coefficient of variation for within person measurements was 2.5% for ankle pressures, and 1.6% for arm pressures. This was similar to results obtained by Schroll and Munk in a study using the same procedure.

Throughout the study, a single observer measured all the blood pressures and examined all participants for carotid bruits. Repeat examinations were carried out on fifty of the 100 participants from one to two months after their initial examination to determine the reproducibility of the data. The repeat examinations were done without knowledge of the results of the first. One person in whom a bruit was not found at the first examination, was found to have a bruit at the second. In no persons did the bruits disappear. The original and repeated average A/A indexes were analyzed for participants examined twice. The mean of the two groups of measurements were 1.089 and 1.109, with the mean of the second group being slightly higher. When subjected to a paired T-test however, the means were not found to be significantly different.

Results

The study population consisted of 37 men and 62 women. The sample was almost exclusively white, with only two black males and one black female. Ages ranged from 61 to 92 with a mean of 72 years. Systolic blood pressure ranged from 160 mm/Hg to 202 mm/Hg with a mean of 170 mm/Hg. Ankle/arm index ranged from .445 to 1.95 with a mean of 1.072.

After excluding sounds referred from the heart and aorta, 24 bruits were found in a total of nineteen persons, a prevalence rate of 19%. All persons were asymptomatic as a result of the exclusion criteria for the SHEP study. The bruits were mostly high pitched and varied from early to pansystolic, with one bruit continuing into the diastolic phase. Location of the bruits varied with approximately one third being restricted to the supraclavicular area, one third involving the bifurcation and one third being along the entire length of the carotid artery.

Patients were divided into three groups according to location of their bruits. When subgroup analyses were performed, the three groups were not found to be significantly different from each other with respect to any other study variables (table 1). The prevalence of low ankle/arm index was distributed equally across the three groups. The mean A/A indexes of the three groups were .97, 1.05 and .97, corresponding to supraclavicular, bifurcation and entire carotid, respectively.

Of the nineteen persons found to have a carotid
bruit, eight were men and eleven were women. There was no significant change of prevalence with age (table 2). Those with carotid bruit were more likely to have a history of angina (21% vs 9%, $p = .15$), and to have a history of cigarette smoking (63% vs 36%, $p = .07$). Those with carotid bruit had a 2.8 times greater chance of having a positive Rose Questionnaire. When this relationship was controlled for smoking, the relative risk was reduced to 2.6. Carotid bruit was not found to be related significantly to systolic blood pressure or serum cholesterol levels (table 3).

According to previous reports, a conservative A/A index of 95% was selected as the lower limit of normal peripheral arterial circulation. An A/A index of less than 95% was found in 12 out of 99 persons (12%). No significant gender difference was found. Ankle/arm index was not found to be significantly correlated with systolic blood pressure ($r = -0.0032, p = .49$), but it was correlated with serum cholesterol ($r = -0.19, p = .03$). As expected, the mean A/A index was lower among those with history of intermittent claudication ($83 \pm 1.10, p < .001$). In addition, current smokers had a significantly greater chance of having a decreased A/A index (36% vs 9%, $p < 0.05$).

Those with carotid bruit had a 3.7 times greater chance of having an abnormal A/A index (table 4). When adjusted for age and smoking, the relationship persisted with a Mantel-Haenszel odds ratio of 3.9, and Mantel-Haenszel Chi square of 7.2 ($p < .05$). The mean A/A index was significantly lower among those with carotid bruit than those without bruit (table 3).

In order to see if there was a direct relationship between carotid bruits and A/A index, the effect of possible confounders was controlled in a stepwise logistic regression analysis (table 5). With a relatively small sample size ($n = 99$), the correlation between A/A index and carotid bruits was borderline significant at a $p = 0.07$ level after controlling for the effect of age, sex, cigarette smoking and systolic blood pressure. However, given the lack of any statistically significant contributions from age, sex or systolic blood pressure, a final model containing only smoking and A/A index was constructed, yielding a $p$-value of .056 for the A/A index coefficient.

### Discussion

The 19% prevalence of asymptomatic bruit found in this study seems high compared with other populations. In the Framingham and Evans County populations, the prevalence rates for the over 65 age group were 6.7% and 7.3% respectively.$^{1,2}$ However this study selected participants with systolic hypertension which has been shown to be associated with increased risk of vascular disease.$^{3-13}$ In the Evans County population, among persons with systolic blood pressure measurements of 160 mmHg or higher, there was a 2.5 fold greater incidence of carotid bruit as compared to those without hypertension. Therefore, the predicted prevalence of carotid bruit in an elderly population with hypertension would be 18.25%. This is similar to the 19% incidence found in the present study.

Due to the selection criteria for the SHEP study there was little variability in age and blood pressure across the population. Ninety-three percent of the study group were between the ages of 60 and 80 and 89% had systolic blood pressures between 160 and 180; thus, any linear relationship between these variables and the presence of carotid bruits would be obscured. In a more varied population, the relationship between systolic blood pressure and the variables of bruit and A/A index might be seen more clearly. The possibility also exists that exclusion criteria as well as blood pressure characteristics may have caused an underestimation of the relationship between bruit and peripheral vascular disease. Further investigation in a normotensive population is needed to confirm the relationship.

### Table 3 Mean of Related Variables by Carotid Bruit

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bruit</th>
<th>Mean</th>
<th>S.D.</th>
<th>No bruit</th>
<th>Mean</th>
<th>S.D.</th>
<th>Combined</th>
<th>Mean</th>
<th>S.D.</th>
<th>$p$-value for 2-tailed T-test*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/A index</td>
<td>.9963</td>
<td>.139</td>
<td></td>
<td>1.097</td>
<td>.183</td>
<td></td>
<td>1.08</td>
<td>.179</td>
<td>.028</td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>168.53</td>
<td>6.31</td>
<td></td>
<td>170.03</td>
<td>9.67</td>
<td></td>
<td>169.73</td>
<td>9.12</td>
<td>.522</td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td>233.84</td>
<td>35.21</td>
<td></td>
<td>234.95</td>
<td>38.55</td>
<td></td>
<td>234.74</td>
<td>37.76</td>
<td>.909</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>71.63</td>
<td>5.36</td>
<td></td>
<td>72.13</td>
<td>6.18</td>
<td></td>
<td>72.03</td>
<td>6.01</td>
<td>.749</td>
<td></td>
</tr>
</tbody>
</table>

*Pooled variance estimates.

### Table 4 Relationship of Carotid Bruit to Ankle/arm Index

<table>
<thead>
<tr>
<th>Ankle/arm index</th>
<th>Bruit</th>
<th>Less than 95%</th>
<th>95% or greater</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>5 (42%)</td>
<td>14 (16%)</td>
<td>19 (19%)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>7 (58%)</td>
<td>73 (84%)</td>
<td>80 (81%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12 (100%)</td>
<td>87 (100%)</td>
<td>99 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

$X^2 = 4.447, p = .035$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>S.E.</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/A index</td>
<td>-3.116</td>
<td>1.687</td>
<td>0.0697</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>-0.030</td>
<td>0.034</td>
<td>0.3842</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.568</td>
<td>0.416</td>
<td>0.1786</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.096</td>
<td>0.291</td>
<td>0.9046</td>
</tr>
<tr>
<td>Age</td>
<td>0.006</td>
<td>0.052</td>
<td>0.7440</td>
</tr>
<tr>
<td>Constant</td>
<td>6.116</td>
<td>6.714</td>
<td>—</td>
</tr>
</tbody>
</table>
The fact that the bruits were not identical regarding location caused us to question whether the different types of bruits represented different types of disease. When subgroup analyses were performed according to location of bruit (supraclavicular, bifurcation or entire carotid), no differences were found between the three groups. Because of the small numbers involved and the resulting decrease in power, the relationship between bruit and A/A index was not significant for any one of these groups individually. Although it may be true that differing locations of bruits may indicate different types of disease, a much larger population would be needed to have any confidence in the results of this particular subgroup analysis.

It has been hypothesized that asymptomatic carotid bruits are an indication of the presence of systemic vascular disease. Asymptomatic bruits have been associated with a greater risk of stroke as well as a greater risk of ischemic heart disease. Diabetics, a population with an increased incidence of systemic vascular disease, experience carotid bruits at nearly twice the rate of non-diabetics. In our study, asymptomatic bruits were associated with a 3.9 times greater risk of occlusive vascular disease to the lower extremities.

Our study adds further evidence to the belief that asymptomatic cervical bruits are in themselves a marker for generalized atherosclerotic disease. Further research is needed to define the natural history of carotid bruits. Non-invasive studies which can demonstrate the extent of carotid occlusive disease might be used in a prospective manner to determine which patients are at risk for stroke, coronary heart disease and peripheral vascular disease.

References

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