Post-stroke carotid ultrasound findings from an incident Tanzanian population

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Abstract

Background: Carotid artery stenosis is not thought to be a major cause of stroke in sub-Saharan Africa (SSA), though data are limited. The aim of this study was to use Duplex ultrasonography to establish the prevalence of significant carotid artery stenosis in an incident stroke population in Tanzania.

Methods: Duplex ultrasound scan was carried out on consecutive cases of stroke, in the latter part of a stroke incidence study, who survived long enough to undergo investigation. As part of the wider incidence study, demographic data, social history, medical history, levels of current disability and findings from computer tomography scan and electrocardiogram were recorded.

Results: One hundred and thirty-two incident stroke cases were identified over the whole study period, of whom 56 (42.2%) underwent Duplex ultrasound. Only one case (female, age 56 years) had evidence of right internal carotid artery stenosis, with a mild degree of stenosis of around 50%. There was no evidence of stenosis of either common carotid artery or of the left internal carotid artery in any cases.

Conclusions: Carotid artery stenosis was rare in our cohort and does not appear to be a significant cause of stroke in our incident cohort.

Introduction

It has been suggested that approximately 30% of patients with ischemic strokes will have carotid stenosis as the etiology of the cerebral event [1]. However, in North American and Caribbean populations, it has been suggested that blacks and whites may have different risk factor profiles for stroke [2]. Hypertension has been suggested as the greatest risk factor for stroke in blacks. In contrast, the prevalence of extracranial carotid stenosis in black populations may be lower [3-6].

A 2009 hospital-based study of 133 patients (96% black) presenting with stroke or transient ischaemic attack from the West Indies identified the prevalence of greater than 50% carotid artery stenosis by Duplex ultrasound to be only 5.6% [7]. The prevalence of other risk factors for stroke was high, with 56% having systolic blood pressure greater than 160 mmHg and 58% having diastolic blood pressure greater than 90 mm Hg and 36% had diabetes mellitus. These results are in line with previous studies of African-Americans [8]. In contrast, a hospital-based study of 101 African-Americans with ischaemic heart disease (IHD) found the prevalence of greater than 50% carotid artery stenosis to be 10.9%, higher than seen in blacks without IHD and in-line with rates found in whites with IHD [9]. Furthermore, the population-based North Manhattan Stroke study found no significant difference in the rates of stroke due to extracranial atherosclerosis between blacks, Hispanics and whites and concluded that differences in the degree of carotid stenosis seen in stroke patients from other studies may be due to selection bias [10].

Data on carotid artery stenosis from sub-Saharan African (SAA) are limited. Umerah found 19 (16.8%) of 113 stroke patients in Zambia to have stenosis of the internal carotid artery by angiography [11]. However, the generalisability of these findings to all stroke cases is limited, with only those cases referred to a radiology department

being included in the study. Few stroke cases attend hospital in SSA, and those that do may not be representative [12]. It is not clear whether the racial differences in carotid artery stenosis, seen by other researchers, are due to genetics, environment or lifestyle, or whether these apparent differences may be due to selection bias.

We have recently reported the incidence of stroke in the Hai district of Tanzania [13]. Sixty-four cases, from 132, had a CT scan carried out within 15 days of incident stroke, of whom 11 (17.2%) had evidence of a haemorrhagic stroke, 52 (81.2%) were normal or had evidence of stroke due to cerebral infarct and one (1.6%) had a subarachnoid haemorrhage. The aim of this study was to investigate the prevalence of carotid artery stenosis in an incident stroke population from SSA.

Materials and methods

This study was approved by the National Institute of Medical Research, Dar-es-Salaam, Tanzania and by the Newcastle and North Tyneside Joint Ethics Committee in the UK.

Recruitment

During the incidence phase of our study we used two methods of case ascertainment [13]. The Tanzanian Stroke Incidence Project (TSIP) combined with verbal autopsy (VA) recruited cases from 15th June 2003 until 15th June 2006 and was conducted in two demographic surveillance sites (DSS); 52 villages in the Hai district of northern Tanzania and 8 geographical divisions of the city of Dar-es-Salaam. The study described here is based on consecutive cases recruited via TSIP from the Hai DSS during the final 18 months of the study.

The Hai DSS has been described previously as part of the Adult Morbidity and Mortality Project (AMMP) [14]. From within a population of 159,814, a total of 453 strokes were recorded in Hai during this time period, 132 identified by TSIP and 346 by VA, with 25 cases identified by both systems. The age-adjusted incidence was 108.6 per 100,000 (95% CI 89.0 to 130.9). Consecutive patients recruited from December 2004 until the end of the study period, who survived long enough to undergo assessment, underwent Duplex carotid ultrasound. Due to lack of personnel and equipment we were unable to carry out Duplex ultrasound on cases from the Hai DSS before December 2004. For the same reason we were unable to carry out any Duplex ultrasound investigations on any cases from the Dar-es-Salaam DSS.

Measurement

Demographic information, social history, past medical history and information about events around the time of the stroke was recorded as part of TSIP. In addition all participants underwent a medical assessment and examination which involved recording blood pressure at no less than 7 days post stroke, pulse rate, cardiac auscultatory findings, height and weight, physical function (Barthel index [15], modified Rankin scale [16]) neurological status (communication, swallowing, vision, muscle activity, sensation), echocardiogram, chest x-ray and computerised tomography (CT) brain scan.

Duplex ultrasound scan

Duplex ultrasound scan was carried out by a consultant radiologist (A.J.) for consecutive patients recruited during 2005 and 2006, using a pulse -wave

Doppler colour-flow and B-mode Doppler ultrasound. The carotid arteries were evaluated with a high-resolution ultrasound (SONOSITE TITAN High resolution ultrasound system, Bothell, WA 98021 USA, 2004) equipped with a broadband linear transducer L38/10-5MHz in B mode, in supine position with the head turned contralateral to the side being examined, at a depth of 2cm. The near and far wall of these arterial segments were scanned longitudinally and transversely to assess the presence of plaques - defined as focal widening relative to adjacent segments, with protrusion into the lumen of only calcified deposits or a combination of calcified and non-calcified material. These measurements were performed for the left and right common carotid artery, bifurcation, and at least 2.5cm away from the bifurcation for the internal carotid artery.

The peak systolic velocity (PSV) and the end diastolic velocity (EDV) of both CCAs as well as the ICAs were recorded. The severity of stenosis of each vessel was calculated using the St Mary's ratio (PSV_{ICA} / EDV_{CCA}) [17].

Statistics

Confidence intervals (CIs) are used for inference regarding normally distributed data (age, blood pressure). When comparing groups an overlap in 95% CIs is taken as evidence of no statistically significant difference between the groups. For categorical data (e.g. sex) odds ratios (ORs) are used to identify between group differences, with a 95% CI for the odds ratio which contains the value 1 indicating no significant difference between the groups.

Results

One hundred and thirty-two incident stroke cases were identified in the Hai DSS between 15th June 2003 and 15th June 2006 as part of the TSIP study. All of the patients who underwent Duplex ultrasound had had carotid artery territory strokes. The median time from incident stroke to assessment (including Duplex carotid ultrasound) was 10 days (range 0-252 days). Although every attempt was made to assess and examine stroke cases as soon after incident stroke as possible, 20 cases died shortly before being identified and 2 died before a full examination could take place.

A total of 56 (42.2%) patients underwent Duplex ultrasound to identify stenosis of the carotid artery. Of these, 38 (67.9%) had had CT head scan carried out within 15 days of stroke onset, with 33 (86.8%) having had an ischaemic stroke and 5 (13.2%) having had a haemorrhagic stroke. The percentage of those with each stroke sub-type who underwent Duplex ultrasound is broadly in-line with the cohort as a whole (81.3% ischaemic stroke, 17.2% haemorrhagic stroke) [13]. Those who underwent Duplex ultrasound and those who did not are compared in **Table 1**; one case of subarachnoid haemorrhage is excluded from this analysis due to the different aetiology and presentation of cases of this stroke subtype. No cases had a diagnosis of claudication or angina, or had had a previous myocardial infarction.

Only one (1.8%) case (female, age 56 years) had evidence of right internal carotid artery stenosis, with a mild degree of stenosis of around 50%. This patient was diagnosed as having had an ischaemic stroke by CT scan. This patient had not had a previous stroke and no significant previous medical history. She was a non-smoker, moderate drinker and worked as a farmer. She was a known hypertensive who had her blood pressure measured every three months and was on antihypertensive medication.

There was no evidence of stenosis of either common carotid artery or of the left internal carotid artery in any cases.

Discussion

In developing countries, increased life expectancy, changes in lifestyle with demographic transition and increasing prevalence of vascular risk factors has modified the pattern of causes of deaths, with an increasing burden of cardiovascular diseases. Community-based studies in African countries have shown that cerebrovascular diseases represent 5% to 10% of the overall cause of death [12], and that the prevalence of important risk factors for stroke (hypertension, obesity, diabetes, smoking etc) is increasing, such that the overall burden of stroke is increasing [18]. High levels of stroke mortality and SSA have been reported [12]. It has previously been suggested that carotid artery disease is less common as a risk factor for ischaemic stroke in SSA. As part of the Johannesburg Hospital Stroke Register study Connor *et al* [19] found that extracranial atherosclerosis was rare in black stroke patients who were admitted to hospital.

This is the first study in SSA to report detailed assessment of carotid arteries by Duplex ultrasound in patients with ischaemic stroke confirmed by CT head scan. Our results suggest that carotid artery stenosis is not common in stroke cases in SSA. Only one case of carotid artery stenosis was detected and the degree of stenosis was only mild. Given the different prevalence of risk factors for stroke between African-Americans and people living in SSA it is not possible to draw firm conclusions regarding the role of socioeconomic, lifestyle or genetic factors in the prevalence of carotid artery stenosis.

We conclude that within our cohort carotid artery stenosis is not a common cause of stroke.

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Conflict of Interest There were no conflicts of interest.

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Contributions

Design/conception – Richard Walker, Ahmed Jusabani, Mark Swai

Data collection – Ahmed Jusabani.

Data analysis - Richard Walker, William K. Gray, Ahmed Jusabani.

Interpretation of results - Richard Walker, Ahmed Jusabani

Writing of paper - Richard Walker, William K. Gray, Ahmed Jusabani,

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Table 1. Comparison of stroke patients who underwent Duplex ultrasound and those who did not

	Underwent Duplex ultrasound	Did not undergo Duplex ultrasound	Significance
Age in years (mean, 95% CI)	68.4 (64.5 to 72.2)	68.4 (64.5 to 72.2)	Not significant
Sex	26 male, 30 female	43 male, 32 female	OR 1.55 (95% CI 0.77 to 3.11), not significant
Systolic blood pressure (mean, 95% CI)	151.9 (142.3 to 161.5); 5 missing values	155.2 (144.6 to 165.8); 21 missing values	Not significant
Diastolic blood pressure (mean, 95% CI)	95.0 (89.1 to 101.0); 5 missing values	95.3 (88.2 to 102.4); 21 missing values	Not significant
On anti-hypertensive medication prior to incident stroke	16 yes, 35 no, 5 missing values	24 yes, 33 no, 18 missing values	OR 1.59 (95% CI 0.72 to 3.51), not significant
Diabetes	3 yes, 48 no, 5 misisng vales	5 yes, 53 no, 17 misisng values	OR 1.51 (95% CI 0.34 to 6.66), not significant