Atherosclerosis involving the cerebral and coronary vessels: A comparative analysis

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Abstract

Patients with ischemic heart diseases are more likely to have stroke than those without and ischemic heart disease is a frequent cause of death among stroke survivors. The risk factors for both are the same. We compared the atherosclerotic pathology in the cerebral, coronary and carotid vessels. A total of 50 autopsy cases were selected for the Baker scoring system The median Baker score ranged was 26.1 in our study. All cases showing severe atherosclerosis of the intracranial vessels were compared with the coronary arteries and the carotid arteries. The percentage of luminal stenosis, severity of stenosis, pattern of narrowing, composition (Fibrous, Fibrofatty, Fatty), inflammation – type and location, calcification, thinning of the vessel wall, microaneurysm formation, thrombus, intraplaque haemorrhage and neovascularisation was documented in detail in cases. Of the 14 cases showing severe intracranial atherosclerosis most also showed severe coronary atherosclerosis but mild carotid atherosclerosis. Infarcts were seen in 7 cases and all had history of hypertension.

Key words: Ischemic heart disease, Coronary artery disease, Cerebrovascular disease, Elderly, Autopsy, Stroke

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Introduction

Patients with ischemic heart disease (IHD) are more likely to have stroke than those without and IHD is a frequent cause of death among stroke survivors[1]. IHD shares risk factors with ischemic stroke. In Caucasians, the degree of extracranial carotid atherosclerosis has been shown to correlate with the extent of coronary atherosclerosis[2]. On the other hand, although earlier autopsy-based studies reported a correlation between ICAS and coronary atherosclerosis, the relationship seems to be less clear[3]. Uehara et al evaluated atherosclerotic lesions in the extracranial and intracranial cerebral arteries using MRA in 67 Japanese patients who underwent selective coronary angiography to estimate the extent of IHD[4]. They compared the patients with IHD with age- and sex-matched control subjects without a history of IHD. The prevalence of carotid artery lesions was significantly higher in the IHD group than in the control group. When the patients with IHD were divided into four groups as zero-, single-, two-, and three vessel disease groups according to the number of affected major coronary branches, extracranial carotid artery lesions were significantly more common in the three vessel group than in the zero- and single-vessel groups. A similar trend was also observed for ICAS, but the difference was not statistically significant. However, the failure to find an association between the severity of ICAS and that of coronary artery disease might be attributable to the small number of patients with ICAS who had two- or three-vessels disease. Recently, a study with a larger number of subjects found that the prevalence of ICAS as well as that of extracranial atherosclerosis increased significantly as coronary atherosclerosis became more severe, from zero- to three-vessel disease[5]. The prevalence of ICAS was high in patients who had severe coronary artery lesions or those scheduled for coronary artery bypass graft (CABG) surgery, although the relationship was less strong than in patients with extracranial carotid disease[6]. Similarly, a more recent study analyzing 246 consecutive patients undergoing CABG surgery showed that the correlation of coronary atherosclerosis was stronger with extracranial carotid atherosclerosis than with ICAS[7]. Arenillas et al reported that the existence of symptomatic vertebral, basilar artery (BA), and intracranial ICA stenosis was an independent marker of myocardial perfusion abnormalities in single-photon emission computed tomography studies[8]. These results, taken together, suggest that ICAS is closely associated with coronary atherosclerosis, but the association is weaker than in extracranial carotid atherosclerosis.

Materials and Methods

The Department of Pathology, in a tertiary care hospital conducted this prospective autopsy between Dec 2011 and Jan 2013. Autopsy cases of patients older than 60 years of age were the subjects used for the study. The study protocol was approved by the institutional ethical review committee. Written informed consent to participate in the study was obtained from the next of kin relatives of the subjects. The clinical records of the subjects were retrieved to obtain detail clinical findings, clinical diagnosis and significant past medical history.

A total of 50 cases were selected for the Baker scoring system. All cases showing severe atherosclerosis of the intracranial vessels were compared with the coronary arteries and the carotid arteries. The percentage of luminal stenosis, severity of stenosis, pattern of narrowing, composition (Fibrous, Fibrofatty, Fatty), inflammation – type and location, calcification, thinning of the vessel wall, microaneurysm formation, thrombus, intraplaque haemorrhage and neovascularisation was documented in detail in all cases.

The brain was suspended in 10% formalin in plastic containers (brain tubs) with the help of thread passed below the basilar artery. The arteries of the circle of Willis were carefully coded for the atherosclerotic process, using the coding system of Baker and his associates[9,10]. The coding technique divides atherosclerosis into four fairly clear-cut groups:

Grade 1+, opacity involving only a small part of the vessel circumference with no narrowing of the lumen;

Grade 2+, (A) diffuse thin plaque that does not involve the entire vessel circumference with minimal luminal narrowing; (B) a small thick plaque that produces less than 25% luminal narrowing;

Grade 3+, (A) a diffuse thin plaque involving the entire vessel circumference with mild luminal narrowing; (B) a localized thick plaque producing 25 to 50% luminal narrowing; and

Grade 4+, (A) a thick plaque involving the entire vessel circumference with moderate or marked luminal narrowing; (B) a localized thick plaque resulting in over 50% luminal narrowing.

In order to determine the extent of the total atherosclerotic process, 22 well-defined areas along the circle of Willis were studied and graded as to the degree of atherosclerosis, according to the above-named coding system. Each of these 22 areas were graded from 0 to 4+. The total numerical value for the degree of the atherosclerotic process could then be obtained by adding the totals of all the graded areas. Thus, since 22 areas were coded and the most severe change was 4 +, using this technique, the greatest degree of atherosclerosis was 22 x 4, or 88. Transverse section / longitudinal sections and serial sections were taken at the point of maximal stenosis and at 5 mm intervals.

Results

Out of 50 cases, 18 (36%) died of acute coronary insufficiency, 1 (2%) of chronic IHD, 2 (4%) of acute myocardial infarction, 7 (14%) of pneumonia, 2 (4%) of renal failure, 5 (10%) of cardiac failure, 3 (6%) of hypovolemic shock, 2 (4%) of intra alveolar haemorrhage and 10 (20%) of miscellaneous causes such as COPD, pulmonary metastases, acute pancreatitis etc.

Out of the total 50 cases, 12 (24%) cases had documented history of hypertension, 23 (46%) cases had history of Ischemic heart disease (IHD), 5 (10%) had history of diabetes mellitus (DM), 3(6%) had history of previous stroke while 12 (24%) cases did not have any of known risk factor.

Of the 50 cases studied, infarcts were seen in 7 (14%) cases, the site being 3 each in basal ganglia and thalamus and 1 in occipital lobe. Out of 3 infarcts in basal ganglia, 1 was a lacunar infarct, 1 micro infarct and 1 was an early infarct. Out of 3 thalamic infarcts, 2 were large recent infarcts and 1 was an old infarct. All of these infarcts had hypertension as risk factor.

A total of 14 out of 50 cases had severe intracranial atherosclerosis, defined as at least 1 vessel showing 70% or more stenosis. On comparing these 14 cases for degree of atherosclerosis in coronary arteries, it was found that 3 (21.4%) of these 14 cases had moderate atherosclerosis, 9 (64.3%) had severe atherosclerosis while 2 (14.3%) had no atherosclerosis, none of the cases had mild atherosclerosis in the coronary arteries. Similarly, for carotid arteries, 7 (50%) cases had mild atherosclerosis, 6 (42.9%) had severe atherosclerosis, 1 (7.1%) case did not have atherosclerosis and no case had moderate carotid atherosclerosis. It is clear that majority of the cases having severe intracranial atherosclerosis also had severe coronary atherosclerosis (64.3%), while majority of the carotids (50%) in these cases had mild atherosclerosis.

Graph 1: Baker score

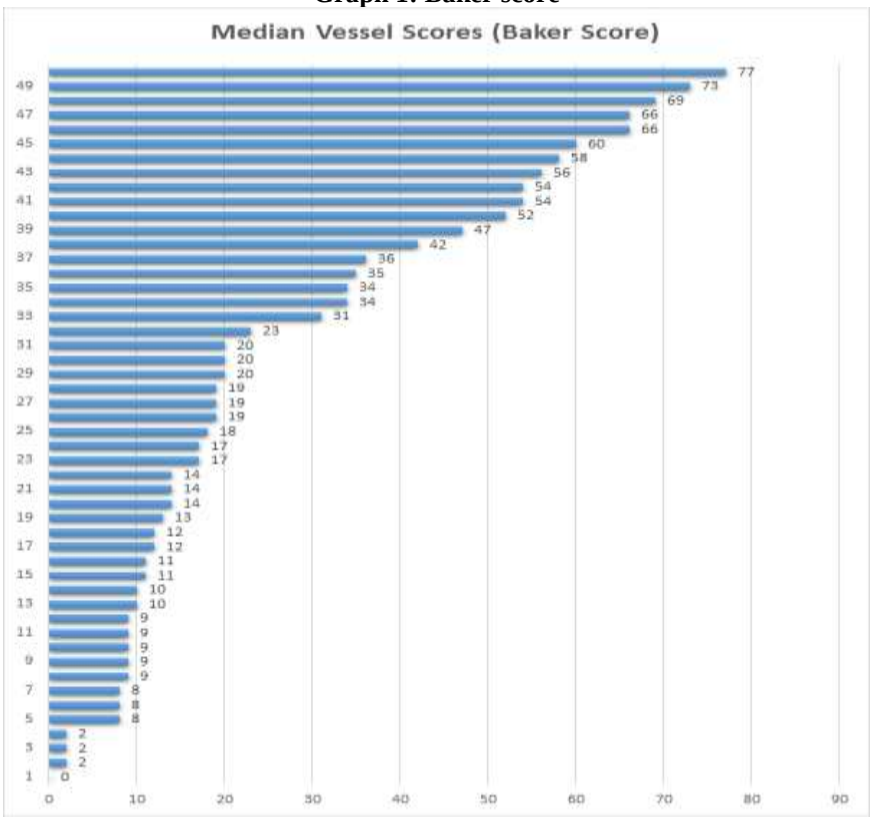

Table 1: **Status of carotids and coronaries in 14 cases having severe intracranial atherosclerosis (defined as at least 1 vessel showing 70% or more luminal narrowing)**

Degree of atherosclerosis	Coronaries	Carotids
Mild	0	7 (50%)
Moderate	3 (21.4%)	0
Severe	9 (64.3%)	6 (42.9%)
No atherosclerosis	2 (14.3%)	1 (7.1%)
Total	14	14

Discussion

Flora G.C. et al in a similar study on western population recorded an average Baker score of 18 and a range of 00 to 60 for 7th to 9th decade[11]. This result shows that intra cranial atherosclerosis is severe in Indian population as compared with the western population. Several studies like Caplan L.R. et.al, McGarry P et.al, Nakamura M et.al, Resch J A et.al have already concluded that intracranial atherosclerosis is severe in Asians as compared to the west, our study corroborates the same as the highest and mean Baker scores in our study are higher than those recorded in western population[12 -15].

Caplan et al reported that the extracranial internal carotid artery (ICA) lesions were closely related to IHD[12]. Uehara et al noted that the prevalence of carotid artery lesions was significantly higher in the IHD group than in the control group[4]. In our study too the proportion of cases with IHD was higher in the group having significant carotid stenosis. Similarly, various studies by Crouse JR et al, Sun Y et al, Cantú-Brito C et al, and Sharrett AR et al have found hypertension to be a major risk factor for carotid atherosclerosis, our study too corroborates the same as 100% of our cases showing significant carotid atherosclerosis, had hypertension as a risk factor[16-19].

A study by Bae HJ et al in Korean population suggested that the correlation of coronary atherosclerosis with extracranial carotid atherosclerosis is stronger than that of coronary atherosclerosis with intracranial atherosclerosis, but we have found the contrary to be true in Indian population[7]. Recently, a study by Uekita K et al with a larger number of subjects found that the prevalence of intracranial as well as that of extracranial carotid atherosclerosis increased significantly as coronary atherosclerosis became more severe, from zero- to three-vessel disease[20]. The prevalence of intracranial atherosclerosis was high in patients who had severe coronary artery lesions or those scheduled for coronary artery bypass graft (CABG) surgery, although

the relationship was less strong than in patients with extracranial carotid disease. Similarly, a more recent study by Bae HJ et al analyzing consecutive patients undergoing CABG surgery showed that the correlation of coronary atherosclerosis was stronger with extracranial carotid atherosclerosis than with ICAS[7]. Finally, Arenillas et al reported that the existence of symptomatic vertebral, basilar artery (BA), and intracranial ICA stenosis was an independent marker of myocardial perfusion abnormalities in single-photon emission computed tomography studies[8]. These results, taken together, suggest that ICAS is closely associated with coronary atherosclerosis, but the association is weaker than in extracranial carotid atherosclerosis. Our study too corroborates this as we found that majority of the cases showing severe intracranial atherosclerosis also showed severe coronary atherosclerosis but mild carotid atherosclerosis.

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