

## ORIGINAL ARTICLES

# Distribution of intracranial vascular lesions in the posterior circulation among Chinese stroke patients

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### Abstract

Distribution of atherosclerotic vascular lesions in the intracranial posterior circulation has not been as well documented as in the anterior circulation. Data regarding this aspect among Asian stroke patients are scarce. In present study, we sought to investigate the distribution of posterior circulation vascular lesions in Chinese stroke patients. We examined consecutive patients with acute ischemic stroke on intracranial vertebral artery and basilar artery with transcranial Doppler ultrasonography. Those (N=33) with abnormalities in vertebrobasilar territory were selected for further study with magnetic resonance angiography and magnetic resonance imaging. Thirty-one of 33 patients were confirmed by magnetic resonance angiography with intracranial posterior vascular lesions. Magnetic resonance angiography findings showed 35% of the patients had lesions in the unilateral or bilateral intracranial vertebral artery without basilar artery involvement. One patient (3%) had an isolated lesion in basilar artery. More than 60% had lesions in basilar artery as well as intracranial vertebral artery. Fifty-two percent of patients had infarct foci within the posterior circulation territory. Infarction occurred most frequently at the pons and cerebellum. In conclusion, Chinese stroke patients have diffuse vascular lesions in the vertebrobasilar territory, rather than a discrete lesion.

### INTRODUCTION

Racial differences in the distribution of cerebrovascular disease have long been of interest. Atherosclerosis of large cerebral arteries is an important cause of cerebrovascular disease, and has been reported to account for 17% to 50% of all ischemic strokes among different ethnic origins.<sup>1-4</sup> Previous angiographic and pathological studies have reported that whites tend to have more severe disease of extracranial arteries, whereas intracranial cerebral arteries were more frequently affected in Orientals or blacks.<sup>5-15</sup> In past, defining the site of the vascular lesions depended on the availability of angiography.<sup>16</sup> However, due to the potential risk of perioperative thromboembolism in the posterior circulation from angiographic procedure, the distribution of atherosclerotic vascular lesions in posterior circulation has been less documented. Data regarding the distribution of vascular lesion in intracranial posterior circulation in Chinese stroke patients are scarce.

With the advent of noninvasive neuroimaging techniques, transcranial Doppler ultrasonography (TCD), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) have been used more and more widely, making detection of posterior circulation vascular lesions attainable. We aimed to assess the distribution of intracranial vascular lesions in posterior circulation among consecutive Chinese acute stroke patients.

### METHODS

We screened consecutive patients with acute stroke who were hospitalized in the Prince of Wales hospital in Hong Kong, which is a general public hospital in this region. All patients underwent computed tomography (CT) of the brain to rule out intracranial hemorrhage. All patients were screened by TCD. Routine TCD examination was performed, including intracranial anterior and posterior large arteries. Only those patients with ultrasonographic lesions within

intracranial vertebrobasilar system were selected for further investigation with MRI and MRA.

The diagnosis of ischemic stroke was confirmed by an experienced neurologist according to patients' clinical manifestations, neurological examination and brain CT findings. We recorded the age, sex and traditional vascular risk factors such as history of hypertension, diabetes mellitus, atrial fibrillation, ischemic heart disease, hyperlipidemia, smoking habit, previous cerebrovascular disease (transient ischemic attack and stroke), and postural hypotension.

TCD examination was performed with an EME TC2000 machine (Nicolet EME, USA) with a 2-MHz pulsed wave transducer. We examined the cerebral arteries through temporal window and the vertebrobasilar arteries through occipital window. In the posterior circulation, we examined posterior cerebral arteries, intracranial vertebral arteries (ICVAs) and basilar artery (BA). The ICVA and BA were insonated at the depth from 60mm to 80mm and from 80mm to 120mm, respectively, with an increment of 4mm. The stenosis criteria of the studied arteries were defined as the local peak systolic velocity (PSV) greater than 90 cm/s with or without turbulent flow. The TCD findings were interpreted separately by a TCD technician and a neurologist.

The MRI was performed with a 1.5 Tesla MR scanner (Gyrosan ACS NT, Philips Medical Systems, Best, Netherlands). Head coil was used. Turbo spin echo T2 axial images were acquired with a field of view of 230mm, 256 x 256 acquisition matrix, slice thickness of 5mm and gap of 0.5mm, time of repetition (TR) of 3300ms, time to echo (TE) of 100ms, one signal average and an acquisition time of 1 minute 32 seconds.

The MRA of the vertebrobasilar arteries were obtained by a 3D phase contrast angiography sequence in the coronal plane with field of view of 200mm, 256 x 256 acquisition matrix, TR of 26ms, TE of 7.6ms, flip angle of 15, one signal average, slice thickness of 1mm and the PC velocity of 50cm/sec. We defined stenosis of an artery if there was more than 50% stenosis of the lumen diameter on MRA. The lesion sites within vertebrobasilar system were described as intracranial vertebral artery lesion and basilar artery lesion.

## RESULTS

We screened 105 acute stroke patients and identified 33 patients with acute ischemic stroke who had stenosis of the vertebrobasilar artery

**Table 1. Clinical Characteristics of Studied Patients**  
(N = 31)

Risk Factors	N (%)
Hypertension	22 (71%)
Diabetes Mellitus	7 (22.6%)
Atrial Fibrillation	3 (9.7%)
Ischemic Heart Disease	6 (19.4%)
Smoking (past & current)	12 (38.7%)
Previous Stroke or TIA	16 (51.6%)
Postural Hypotension	1 (3.2%)

according to TCD criteria. Two patients were excluded from the analysis due to absence of stenosis in the posterior circulation on MRA. Among remaining 31 patients, there were 16 men (52%) and their ages ranged from 35 years to 84 years (mean  $69 \pm 9.6$ ). Patients' characteristics were shown in Table 1. More than two-thirds of the patients had hypertension. Over half of the patients experienced transient ischemic attack or stroke before the indexed stroke. Nearly 40% of these patients were current or past smokers. Atrial fibrillation was found in 3 patients (9.7%), and ischemic heart disease in 6 patients (19.4%).

Considering the clinical manifestation, two patients had stupor, two had diplopia, and two had bilateral weakness. Among other three patients, ataxia, nystagmus or vomiting was found. Facial weakness was present in three patients. More than half of the patients had hemiparesis (58%), slurred speech (51%), and 30% had vertigo and dysarthria.

Based on MRA findings of these 31 patients, ICVA lesions were found in 97%, including either unilateral or bilateral lesions with or without BA involvement. Forty percent of unilateral and 75% of bilateral ICVA disease had associated BA disease. For unilateral ICVA lesion, more right sided lesion was found. Aside from BA disease, the percentage of involvement of either bilateral ICVAs (16%) or unilateral ICVA (19%) was somewhat different. Only one patient had an isolated lesion in the BA without ICVA abnormality. Most patients had more than one vascular lesion, including the pattern of bilateral ICVAs associated with BA involvement (48%), the pattern of bilateral ICVAs sparing BA (16%), or the pattern of unilateral ICVA and BA stenoses (13%). More than 60% patients had lesions distributed in BA, as well as in ICVAs. The distribution of the lesion sites in MRA study was summarized in Figure 1.

Every patient had infarct found on MRI film

within anterior or/and posterior circulation territory. Approximately half of them (16 patients) showed infarct foci located within the posterior circulation territory. Of these 16 patients, 9 (56%) had isolated infarct, including 5 cerebellar infarcts, 3 pontine infarcts and 1 thalamic infarct. Other 7 patients had two infarct foci in posterior circulation territory, including 3 distributed in both pons and cerebellum (one with bilateral cerebellum and pons involved), 1 in both cerebellum and thalamus, 1 in both pons and occipital lobe, 1 in both midbrain and cerebellum, and 1 in midbrain and pons. None of our patients had medullary infarct. MRAs of the 16 patients showed 14 (87.5%) with more than one vessel disease. Comparing the infarct foci with their MRA films, one patient with isolated cerebellar infarct showed unilateral ICVA disease, and one

patient with isolated thalamus infarct with isolated BA stenosis, while other 7 patients with isolated infarct and all 7 patients with two foci within posterior circulation had at least two- vessel stenoses. Five (71%) of 7 patients with two foci and 4 (44%) of 9 patients with isolated infarct showed diffuse stenoses involving bilateral ICVAs and BA. The correlation between the distribution of vascular lesions and the location of the infarctions within posterior circulation was summarized in Table 2. Other 17 patients had infarctions within the anterior circulation, which were not analyzed in this study.

## DISCUSSION

In this present study among Chinese ischemic stroke patients with intracranial posterior occlusive disease proven by noninvasive neuro-imaging examinations, more than 60% patients had diffuse lesions distributed in BA and both ICVAs. Most patients had more than one vascular lesion (77%). Isolated artery lesion, either unilateral ICVA lesion or isolated BA lesion, was uncommon in this study.

Cerebellum and pons are the commonest sites for infarction.

Race, was the only factor that increased the risk of intracranial posterior circulation occlusive disease.<sup>12</sup> Hutchinson and Yates suggested at necropsy that the cervical portion of the vertebral artery was a common site of occlusive lesion, while intracranial disease was rare.<sup>17</sup>

Figure 1: The distribution of lesion sites in MRA study

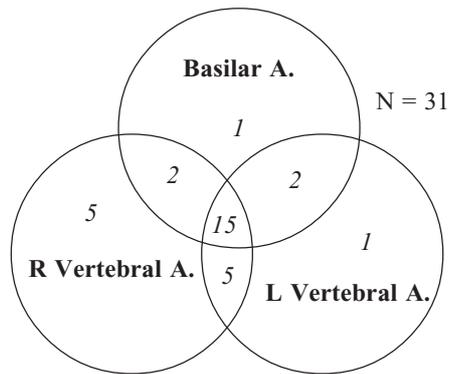


Table 2. Correlation of Posterior Circulation Lesions in MRA and MRI (N = 16)

MRA\MRI	Cerebellum	Pons	Mid-brain	Thalamus	Occipital lobe
ICVA only	3	2	1	0	0
BA only	0	0	0	1	0
BA& ICVA	7	6	1	1	1

ICVA denotes intracranial vertebral artery, and BA basilar artery.

Table 3. Comparison of our results and the NEMC Posterior Circulation Registry<sup>26</sup>

ICVA Disease	Present Study No of patients (%)	NEMC Posterior Circulation Registry No of patients (%)
Unilateral ICVA only	6 (20)	35 (47)
Bilateral ICVA sparing BA	5 (17)	19 (25)
Unilateral ICVA & BA	4 (13)	11 (15)
Bilateral ICVA & BA	15 (50)	10 (13)
Total	30 (100)	75 (100)

Chi-squared test  $p < 0.001$

ICVA denotes intracranial vertebral artery, and BA basilar artery.

Subsequently, angiographic studies and post-mortem examinations corroborated the earlier pathologic findings and also addressed intracranial posterior circulation lesions were more frequent in blacks, although vertebral artery and basilar artery disease was not uncommon in whites.<sup>5,18-20</sup> Gorelick et al in a biracial angiographic study of 44 cases observed that extracranial vertebral artery was affected more severely and more frequently in whites, whereas more severe and more symptomatic intracranial branch disease was predominant in blacks.<sup>12</sup> For Chinese population, a general necropsy study of 114 consecutive Hong Kong Chinese patients found that intracranial vertebral artery and basilar artery are frequently affected.<sup>21</sup>

We compare our data with the results from the study on intracranial vertebral artery disease in the New England Medical Center (NEMC) Posterior Circulation Registry. The data were summarized in Table 3. The percentage of unilateral ICVA disease without BA lesion was much more common in the NEMC Posterior Circulation Registry (47%) than ours (20%). The percentage of unilateral ICVA disease associated with BA lesion was similar in the two studies. The proportion of bilateral ICVAs disease in present study (67%) was over 1.5 times that of NEMC Posterior Circulation Registry (38%). In patients with bilateral ICVAs disease, three-quarters of patients had tandem BA lesion in our study, in comparison to 34% patients in NEMC Posterior Circulation Registry. Eighty percent of patients in the present study were found to have more than one artery lesion, whereas nearly half of the patients had isolated lesion in NEMC Posterior Circulation Registry. It should be noted that the NEMC Posterior Circulation Registry was a registry of symptomatic posterior circulation disease, whereas our report probably include patients whose posterior circulation disease were asymptomatic. However, of our 16 patients with posterior circulation territory infarcts, 87.5% had more than one vessel disease. Therefore, this comparison supported that Chinese stroke patients had more diffused large-artery lesions within posterior circulation territory.

Our findings may have important clinical implications. Currently, there is no specific treatment for intracranial stenosis in the posterior circulation. Anticoagulation is an option which is now being investigated.<sup>22</sup> Another strategy is to use angioplasty with<sup>23,24</sup> or without<sup>25</sup> stenting. Our data suggest that medical therapy may be

more suitable in our population because of the diffuse nature of stenosis, which render angioplasty technically more difficult.

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