We studied the pattern and outcome of strokes in 200 Saudi patients. Cerebral infarction constituted 87% of strokes, subarachnoid hemorrhage 4.5%, cerebral hemorrhage 6.5%, and venous infarction 2%. The vessel most commonly involved was part or all of the middle cerebral artery, constituting 52% (90) of the 174 arterial infarcts. Lacunar infarcts were seen in 21% (37) of the patients with arterial infarcts. Among all 200 patients, 8% died and 8% had secondary generalized seizures. Hypertension occurred in 41% of the 174 patients with arterial infarcts and 62% of the 13 with cerebral hemorrhages. The highest incidence of hypertension as a risk factor was among those with lacunar infarcts (81%), ganglionic cerebral hemorrhages (80%), and infarcts of deep branches of the middle cerebral artery (57%). Embolic infarcts due to rheumatic heart disease constituted 11% of all arterial infarcts. We conclude that our pattern of strokes is similar to that of the west rather than that of the Japanese, but with less frequent arteriovenous malformations and aneurysms. (Stroke 1991;22:1173–1176)

The Arabian Peninsula is located between latitudes 10° and 30° north. Saudi Arabia is the largest country in the peninsula, with an area of 2,150,000 km² and a population of 10 million. Riyadh is the capital of the kingdom, with a population of 1 million, and King Khalid University Hospital is one of two main hospitals in Riyadh providing free access and care to all Saudis. The Neurology Unit in this hospital is the largest in the kingdom with 24-hour emergency service, but private medical care, especially in neurology, is limited in Riyadh.

Stroke data banks and stroke registries provide the best information about cerebrovascular diseases. However, because these methods are not yet available nationwide in Saudi Arabia, the incidence, prevalence, and pattern of strokes are not yet known in Saudis. We studied all patients with first-ever stroke during the period 1984–1989 in an attempt to establish the pattern of strokes in Saudis and to identify the effect of different risk factors for different sites of stroke.

Subjects and Methods

During the period January 1984–December 1989, we evaluated all patients admitted with a clinical diagnosis of first-ever stroke. Two hundred thirty-one patients were admitted from the emergency room or referred from different health centers in Riyadh; few patients were referred from hospitals outside Riyadh for further evaluation. The patients were of different occupations and social classes.

Two hundred patients had a definite lesion by computed tomography (CT) of the brain performed within 3 days, 10 days, or 1 month after the stroke. We excluded the 20 patients whose CT scan was negative after 1 month and the 11 patients in whom brain CT was not done.

We defined stroke as rapidly developing clinical symptoms and/or signs of focal and sometimes global loss of cerebral function with symptoms lasting for >24 hours or leading to death, with no apparent cause other than that of vascular origin. Cerebral infarct was defined as a hypodense lesion on brain CT, with a topography corresponding to the territory of a cerebral vessel as defined by Damasio and Bories et al. Hemorrhagic infarct was identified as an area of low attenuation conforming to a vascular territory within which a single nonhomogeneous area or multiple areas of high attenuation were present with characteristic blood density. Lacunar infarct was defined as a constellation of clinical symptoms and signs showing a high correlation with small, deep, rounded infarcts due to a single penetrating small arterial occlusion as confirmed by CT. We recognized the four lacunar syndromes pure motor stroke, pure sensory stroke, sensorimotor stroke, and ataxic hemiparesis. Border zone infarcts were those occurring in border zones between two main artery territories as defined by Bogousslavsky and Regli, Damasio, and Bories et al. Cerebral hemorrhage was diagnosed as a hypodense area on brain CT with or
TABLE 1. Pattern of Strokes in 200 Saudis

<table>
<thead>
<tr>
<th>Stroke type</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial infarction</td>
<td>174</td>
<td>87</td>
</tr>
<tr>
<td>Venous infarction</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>9</td>
<td>4.5</td>
</tr>
<tr>
<td>Cerebral hemorrhage</td>
<td>13</td>
<td>6.5</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>

without intraventricular leak and classified as ganglionic when occurring in the basal ganglion (thalamic, lenticular, or caudate) or lobar when located in the frontal, temporal, parietal, or occipital regions. Subarachnoid hemorrhage was identified by the presence of blood in the subarachnoid space on CT or by bloody cerebrospinal fluid in patients with a normal CT scan. Venous infarct was confirmed with cerebral angiography or arterial digital subtraction arteriography.

We studied the four risk factors hypertension, diabetes mellitus, ischemic heart disease, and rheumatic heart disease. The statistical assessment of the prevalence of hypertension and diabetes in patients with different stroke subtypes was done by applying the $\chi^2$ test. To determine hypertension, we measured blood pressure twice in all patients and considered readings of $\geq 150/90$ mm Hg after admission from the emergency room as abnormal. Cardiac clinical evaluation was completed in all patients, and echocardiography was done in certain patients with rheumatic or ischemic heart disease. Diabetic patients were defined as those whose fasting blood glucose concentration was $>7.8$ mmol/l.

Results

There were more men with strokes of all types than women, with the overall male:female ratio being 1.4:1. Table 1 shows the pattern of strokes, with cerebral infarct being the most common and venous infarct the least common.

The anatomic location of the cerebral arterial infarcts are shown in Table 2. Infarcts in the anterior circulation constituted 59% while those in the posterior circulation constituted 17% of all arterial infarcts. Six patients had border zone infarcts, mainly with Wernicke's aphasia, pure word deafness, partial complex seizures, and visual field defects. Lacunar infarcts constituted 18.5% of all strokes and 21% of all arterial infarcts. Table 3 shows the frequencies of different lacunar syndromes with the sites of the lesions.

Venous infarcts were seen in four patients; three were young women (two in the postpartum period, one in the first trimester of pregnancy). These patients presented with headache, papilledema, convulsions, and speech problems. The one man, admitted with carcinomatosis, had multiple venous infarcts confirmed by brain CT and four-vessel cerebral arteriography.

Spontaneous intracranial hemorrhage was found in 22 patients, nine (4.5%) with subarachnoid hemorrhage and 13 (6.5%) with cerebral hemorrhage.

### Table 2: Anatomic Location of Arterial Infarct in 174 Saudi Patients

<table>
<thead>
<tr>
<th>Location</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA</td>
<td>102</td>
<td>59</td>
</tr>
<tr>
<td>Entire ICA</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>MCA</td>
<td>90</td>
<td>52</td>
</tr>
<tr>
<td>Entire MCA</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Superficial MCA</td>
<td>59</td>
<td>34</td>
</tr>
<tr>
<td>Deep MCA</td>
<td>28</td>
<td>16</td>
</tr>
<tr>
<td>Lenticulostriate artery</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Anterior choroidal artery</td>
<td>11</td>
<td>6.5</td>
</tr>
<tr>
<td>Anterior cerebral artery</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Vertebralbasilar artery</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>Posterior cerebral artery</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Posterior inferior cerebellar artery</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Border zone infarcts</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Lacunes</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>174</td>
<td>100</td>
</tr>
</tbody>
</table>

ICA, internal carotid artery; MCA, middle cerebral artery.

Ganglionic cerebral hemorrhage (10) was more common than lobar hemorrhage (three).

Table 4 compares risk factors among the 174 patients with arterial infarcts and 13 patients with cerebral hemorrhage. The highest incidence of hypertension was in patients with lacunar infarcts (81%), ganglionic cerebral hemorrhage (80%), or infarcts of the deep branches of the middle cerebral artery (57%) ($p<0.001$, $\chi^2=49.12$). Diabetes was equally common among patients with infarcts in the deep or superficial branches of the anterior or posterior circulations and patients with lacunar infarcts ($p<0.69$, $\chi^2=3.95$). Embolic infarcts due to rheumatic heart disease were seen in 11% of the patients with arterial infarcts, equally common among those with infarcts in the anterior or posterior circulations. Only two patients had embolic infarcts in the territory of the lenticulostriate artery.

Among all 200 patients, 16 (8%) died in the hospital. Ten (6%) of these were from the 174 with arterial infarcts, one (25%) was from among the four...
with venous infarcts, and five (23%) were from among the 22 patients with cerebral or subarachnoid hemorrhage. Epilepsy developed in 16 patients (8%) during a follow-up of 1–4 years.

Discussion

Rather than being population-based, our study consists of patients with first-ever stroke and is negatively biased toward certain categories such as rapidly lethal strokes or those with rapidly reversible symptoms. However, our study is very important in defining the pattern and outcome of strokes in a particular ethnic group not studied before.

Our study agrees with others in finding a male preponderance.8”18 The overall male:female ratio was consistent in all types of arterial infarcts, but not in venous infarcts.

We studied only a few risk factors but found the incidence of embolic infarction of cardiac origin to be higher than that reported in the west because the incidence of rheumatic valvular lesions is still high in Saudi Arabia and other developing countries. 19 We found diabetes and hypertension to have the same frequencies as reported in the literature. 20’21 However, the frequency of hypertension was not the same in all stroke subtypes, as it was for diabetes mellitus.

The pattern of strokes in Saudis was more like that in Europeans13-15-22-25 than like that in Chinese26 and Japanese.16,27,28 Ganglionic hemorrhage related to hypertension had the same frequency as in the west, but subarachnoid hemorrhage and lobar intracerebral hemorrhage due to arteriovenous malformations had lower incidences, suggesting that aneurysm and arteriovenous malformations are less common in this ethnic group.29 Our findings on lacunar infarcts are comparable to those in other studies, which indicate that lacunar syndromes are more common in the elderly, in hypertensive persons, and in males.10 The frequency of venous infarcts was higher in our study than in others8,30 but reflects a certain bias because most such cases are referred to our institutes for specific investigations not available in small hospitals in the kingdom.

In conclusion, our study, though not community-based, reflects the pattern of strokes in Saudis and outlines some of the risk factors.

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