Pattern of circadian rhythm of blood pressure in acute stroke

Dr. Akande Oladimeji Ajayi, Dr. Ebenezer Adekunle Ajayi, Dr. Kehinde Adesola Adekeye, Dr Olusegun Adesola Busari

1Department of Medicine, Ekiti State University Teaching Hospital, Nigeria.
2Department of Medicine, Federal Medical Centre, PMB 201, Ido-Ekiti, Nigeria.

*Corresponding author E-mail: dejiajayi2@yahoo.co.uk.

Accepted 27 March 2013

Background and Purpose: Circadian rhythm in blood pressure (BP) has been recognized as a prognostic marker in hypertensive patients. We embarked on this study to establish the pattern of circadian rhythm of BP in our stroke patients and to compare this with results elsewhere.

Methods: Of the 61 patients with acute stroke, 34 met the inclusion criteria of presenting within 72 hours of stroke onset and were included in the study. BP was recorded manually every 2 hours with a standard mercury sphygmomanometer. Daytime BPs was recorded from 8:00 a.m to 7:59 p.m while the night time BPs was recorded from 8:00 p.m to 7:59 a.m.

Results: The mean age of the studied population was 65±11years. The risk factors identified for acute stroke were hypertension, diabetes and smoking. The mean daytime, nighttime and 24 hours BP were higher in the haemorrhagic than in the ischaemic stroke group. Twenty two of the patients were non-dippers while twelve were dippers. Admission mean systolic blood pressure (SBP) was found to be higher in patients with haemorrhagic stroke compared to those with ischaemic stroke, p value= 0.003.

About 65% of the patients were non dippers and had < 10% drop in nighttime BP.

Conclusions: The findings here showed a reduced circadian BP variation after stroke. It also showed a higher mean admission, daytime, nighttime and 24 hour BP in patients with haemorrhagic stroke compared to those with ischaemic stroke. It equally showed a statistically significant difference in BP in both dippers and non-dippers (p < 0.05).

Key words: Stroke, blood pressure, circadian rhythm.

INTRODUCTION

Stroke is the culmination of a heterogeneous group of cerebrovascular diseases that is manifested as ischaemia or haemorrhage of one or more blood vessels of the brain (Manfredini et al., 2005). It is a medical problem with socio-economic imparts worldwide. It is the third major cause of mortality, and also a major cause of disability and institutionalization of older persons (Jain et al., 2004).

Blood pressure (BP) is a continuous variable and usually displays a biorhythm in both normotensive and hypertensive individuals (Lip et al., 1997). During sleep, BP in most people is between 10% and 20% lower than the mean daytime value. On arousal and the start of the day-to-day activities, there is a surge in BP that may last for between 4 to 6 hours. Cardiovascular events, such as myocardial infarction, ischaemia and stroke are more frequent in the early hours of the morning soon after waking, than at other times of the day (Giles, 2005). Several haemodynamic, neurohumoral and other factors interact to produce this circadian variation in BP (White, 2003, Shea et al., 2011; Giles, 2000).

Hypertension is the dominant risk factor and the prognostic indicator in patients with stroke [Jain et al., 2004; Feigin, 2003; Broderick et al., 2007; Lip et al., 1997]. A history of untreated hypertension increases the risk of stroke 3 to 4 times (Davis et al., 1987) In healthy people, circadian rhythm of systolic and diastolic BP is well established (Aschoff, 1965) Deviations from normal patterns have been correlated with target organ disease such as left ventricular hypertrophy, retinopathy, renal disease and stroke (Verdecchia et al., 1990). The risk of stroke is directly related to BP elevations and its control. Sleep systolic and early morning systolic BPs are more predictive for stroke events than daytime SBP, especially in the elderly (Siddiqi et al., 2011).

Ischaemic stroke occurs in 20-40% of patients at night. In Nigeria, ischaemic strokes constituted 64%, haemorrhagic strokes accounted for 19%, and...
Among the elderly hypertensive subjects, extreme dippers with marked nocturnal BP as well as non-dippers with absent nocturnal fall in BP are prone to cerebrovascular disease when compared with those with appropriate nocturnal BP fall. Non-dipping and reverse dipping are the common patterns of circadian BP variation seen in acute stroke patients (Pandian et al., 2006).

Various studies have shown different changes in circadian BP pattern after stroke depending on the pathogenesis and location of the stroke (Sander et al., 1994). Considerable controversy still surrounds the changes in BP in various subtypes of stroke and problem of management of elevated BP after stroke. Therefore, we studied the circadian rhythm of BP in patients following acute stroke.

MATERIALS AND METHODS

This study was carried out at the medical emergency Department of the Federal Medical Centre, Ido Ekiti, Nigeria from July 2010 to December 2010. Thirty four patients who met the inclusion criteria of presenting within 72 hours of stroke onset were enrolled into the study. The study was approved by the Ethical and Research Committee of the hospital.

All patients had a detailed clinical and laboratory studies carried out. BP was recorded manually every 2 hours with a standard mercury sphygmomanometer applied to the side ipsilateral to intracranial lesion after relevant BP difference between the two limbs was ruled out. Daytime was taken to be between 8:00 a.m –7:59 p.m while the nighttime was taken to be between 8:00 p.m – 7:59 a.m.

The normal variation in BP is characterized by a 10% to 20% reduction in BP from day to night. Individuals with this decline in night-time BP are known as ‘dippers’, and those who experience a blunted decline in night-time BP are known as ‘nondippers’.

The stroke patients were classified into haemorrhagic or ischaemic using the World Health Organization criteria (WHO, 1978). Classification of dipping in blood pressure was based on the American Heart Association’s calculation (Holt-Lunstad et al., 2009), using (SBP) as follows:

\[ \text{Dip} = (1 - \text{SBP Sleeping}/\text{SBP Waking}) \times 100\% \] (Table 1)

Data obtained were analyzed using the statistical package for social science (SPPS, version 15) statistical software. A value of p< 0.05 was considered statistically significant.

RESULTS

The mean age of the studied population was 65±11 years (range 45 to 92 years). The risk factors identified for acute stroke were hypertension (24 patients, 71%), diabetes (5 patients, 15%) and smoking (4 patients, 12%). See Table 2. Multiple risk factors were found in 85% of the patients. None of the patients tested positive for HIV or VDRL. Of the twenty four that were hypertensive, only eight claimed to be regular on their medications. Majority of the patients 22 (65%) were educated (at least elementary school education), while the remaining 12 (35%), had no formal education.

Patients with prior history of hypertension had a statistically significant higher admission systolic and diastolic blood pressures (173±41mmHg and 102±19mmHg respectively) than those without prior hypertension (134±41mmHg and 75±mmHg respectively), p <0.05. Admission mean SBP was 162±45mmHg and this was found to be statistically significant in patients with haemorrhagic stroke (174±40mmHg) compared to those with ischaemic stroke (140±21mmHg), p = 0.003. Also, the mean DBP on admission was statistically significant in patients with haemorrhagic stroke (100±25mmHg) than those with ischaemic stroke (80±27mmHg), p = 0.039. We also found that the mean daytime, nighttime and 24hours BP were higher in the haemorrhagic group than in the ischaemic group Table 3.

Twenty two of the patients were non-dippers while twelve were dippers. Of the 22 non-dippers, 10 were haemorrhagic while 12 were ischaemic strokes. Three out of the 12 dippers were haemorrhagic, while 9 were ischaemic stroke. Length of stay on admission and neurological deficit were greater in non-dippers than in the dippers. Also, mortality was more in the non-dippers than in dippers. We found a statistically significant difference in BP changes in these two groups (p value< 0.05) Table 4.

DISCUSSION

Circadian rhythm in BP has been recognized as a prognostic marker in hypertensive patients (Anwar et al., 2001). In normotensive as well as in non complicated hypertensive patients, a significant nocturnal decline in BP occurs. Non dipper hypertensive patients have a worse prognosis as a result of increased target organ damage (Verdecchia, 2000). This was corroborated by the high mortality rate among the nondippers from our study. In this group, significant left ventricular hypertrophy, microalbuminuria and stroke frequency have been described (Verdecchia, 2000).

Hypertension is a treatable single risk factor for stroke (Hu et al., 1992). It is associated with an increased risk of all major stroke subtypes (Jain et al., 2004). The
Table 1. Classification of dipping in blood pressure is based on the American Heart Association.

<table>
<thead>
<tr>
<th>Range</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0%</td>
<td>Reverse dipper</td>
</tr>
<tr>
<td>0% - 10%</td>
<td>Non-dipper</td>
</tr>
<tr>
<td>10% - 20%</td>
<td>Dipper</td>
</tr>
<tr>
<td>&gt;20%</td>
<td>Extreme dipper</td>
</tr>
</tbody>
</table>

Table 2. Demographic variables of patients with stroke.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total</th>
<th>Dippers</th>
<th>Non-dippers</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of patients</td>
<td>34</td>
<td>12</td>
<td>22</td>
<td>NS</td>
</tr>
<tr>
<td>Age (years)</td>
<td>65±11</td>
<td>71±18</td>
<td>62±10</td>
<td>0.026</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>1:1</td>
<td>5:1</td>
<td>1:2</td>
<td>NS</td>
</tr>
<tr>
<td>Hypertension</td>
<td>24(70.5%)</td>
<td>9(75%)</td>
<td>15(68%)</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5(14.7%)</td>
<td>4(33%)</td>
<td>1(4.5%)</td>
<td>0.023</td>
</tr>
<tr>
<td>Smoking</td>
<td>4(11.8%)</td>
<td>2(17%)</td>
<td>2(9%)</td>
<td>NS</td>
</tr>
<tr>
<td>Alcohol</td>
<td>7(20.6%)</td>
<td>4(33%)</td>
<td>3(13.6%)</td>
<td>NS</td>
</tr>
<tr>
<td>TIA*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAD**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HIV***</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VDRL****</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Transient ischaemic attack  
** Coronary artery disease  
*** Human Immunodeficiency Virus  
**** Veneral Disease Research Laboratory test

Table 3. Ischaemic Vs Haemorrhagic stroke blood pressure changes.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total</th>
<th>Ischaemic 21</th>
<th>Haemorrhagic 13</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Admission BP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP*</td>
<td>162±45</td>
<td>149±40</td>
<td>174±42</td>
<td>&lt; 0.003</td>
</tr>
<tr>
<td>DBP**</td>
<td>94±23</td>
<td>82±27</td>
<td>100±25</td>
<td>&lt; 0.039</td>
</tr>
<tr>
<td>MAP***</td>
<td>115±31</td>
<td>91±19</td>
<td>126±13</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mean Daytime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>158±30</td>
<td>140±32</td>
<td>170±27</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>DBP</td>
<td>94±18</td>
<td>84±19</td>
<td>108±17</td>
<td>&lt; 0.0007</td>
</tr>
<tr>
<td>MAP</td>
<td>105±27</td>
<td>112±29</td>
<td>118±24</td>
<td>&lt; 0.012</td>
</tr>
<tr>
<td>Mean Nighttime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>158±30</td>
<td>140±32</td>
<td>170±27</td>
<td>&lt; 0.008</td>
</tr>
<tr>
<td>DBP</td>
<td>94±18</td>
<td>84±19</td>
<td>108±17</td>
<td>&lt; 0.003</td>
</tr>
<tr>
<td>MAP</td>
<td>104±25</td>
<td>112±29</td>
<td>118±24</td>
<td>&lt; 0.003</td>
</tr>
<tr>
<td>Mean 24 Hour BP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP</td>
<td>161±26</td>
<td>142±18</td>
<td>185±52</td>
<td>&lt; 0.030</td>
</tr>
<tr>
<td>DBP</td>
<td>95±16</td>
<td>84±20</td>
<td>104±37</td>
<td>&lt; 0.049</td>
</tr>
<tr>
<td>MAP</td>
<td>107±23</td>
<td>90±15</td>
<td>118±12</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

* Systolic, ** Diastolic, *** Mean arterial blood pressure

Reduction of BP in primary prevention studies appears to reduce the relative risk of all stroke subtypes. Twenty-four (71%) of our patients were known hypertensives prior to the incident of stroke. The mean day-night difference in both SBP and DBP was much less than the 10% day-night difference normally seen in dippers. The phenomenon of nondipping has been seen in medical conditions as diverse as malignant hypertension, renal disease, Cushing’s disease, phaeochromocytoma, polycystic kidney disease, strokes, diabetes with autonomic neuropathy, heart failure and preeclamptic toxaemias (Pickering, 1990; Pickering 1994).
The interpretation of the reduced day-night difference or nondipping is complicated by some factors such as the sleep patterns in any patient population, the appreciable arousal from sleep on cuff inflation in some patients and co-morbid medical conditions (Feigin et al., 2003). The difference in the incidence of non-dipping and dipping was highly significant in this study and therefore these factors can be discounted.

The mechanisms that accounted for the initial post stroke BP elevations are unclear. Psychological stress from the acute hospital admission, central mechanisms (Olsson et al., 1992; Meyer et al., 1973), catecholamines/cortisol release, and a white coat hypertension effect, have been postulated. It is also argued that the absence of the normal dipping results in a higher 24 hour BP load and may have prognostic implications. In particular, hypertensive patients who are non dippers may have more target organ damage than those with the normal variation in BP (Verdecchia et al., 1990).

We found from this study that nondipping in BP occurred in majority of patients with stroke irrespective of the underlying disease nature. Yamamoto et al. (1995), had proposed that nocturnal BP decline might be associated with the extent, type of stroke and the specific location of the intracranial lesion. Diminished nocturnal BP could be caused by an injury to the central autoimmune nervous system. This in effect, causes reduced sympathetic increased parasympathetic activities at night. The risk factors identified for acute stroke in this study were; hypertension (24 patients, 71%), diabetes (5 patients, 15%) and smoking (4 patients, 12%). Multiple risk factors were found in 85% of the patients.

None of the risk factors, clinical or laboratory variables or BP changes differed significantly between the two subgroups of dippers and non dippers and this was similar to the findings of Jain et al. (2004). Similar to the findings of Jain et al. (2004), our study found that admission BP was higher in patients with previous history of hypertension. Britton et al. (1986) have demonstrated that a history of hypertension was common amongst patients with stroke than the controls (46% vs 26%). Wallace et al. (1981) showed that the majority of stroke patients were hypertensive during the first twenty four hours, but declined soon afterwards. The reasons for this are not well known.

Contrary to the study of Jain et al., 2004), our study showed a positive correlation between the admission SBP and DBP with the age of the patient. (Carlberg et al., 1991) found in their study a correlation of age with SBP on admission in patients with haemorrhagic stroke. Similar to the study of (White, 2007) our study demonstrated significant correlation between nondippers and incidence of strokes. . Length of stay on admission and neurological deficit were greater in non-dippers than in the dippers. Also, mortality was more in the non-dippers than in dippers. We found a statistically significant difference in BP changes in these two groups (p value< 0.05). This finding was similar to that found by Routledge et al. (2007).

This present study demonstrated a higher SBP and DBP in patients with haemorrhagic stroke compared to those with ischaemic stroke and this was similar to that found by (Lip et al., 1997). This study was limited by the use of only 24hour period of manual blood pressure monitoring and the non availability of neuroimaging confirmation. Also, we did not do a statistical comparison of the reduced BP values obtained here with that of the normal population.

**CONCLUSION**

The findings in this study showed abolition of the normal
diurnal variation of BP in strokes. It also showed a higher significant mean admission, daytime, nighttime and 24-hour BP in patients with haemorrhagic stroke compared to those with ischaemic stroke. It equally showed a statistically significant difference in BP in both dippers and non-dippers (p < 0.05).

REFERENCES


