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Ambulatory blood pressure and its response to exercise in the elderly

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Thirty-three elderly subjects — 9 hypertensives, 15 with a history of unexplained falls and 9 asymptomatic volunteers, underwent 24 h continuous intra-arterial ambulatory blood pressure (BP) monitoring under controlled conditions. During this time their response to standardized exercise and baroreflex activity were assessed.

The casual BP of the hypertensives was significantly higher than that of the other groups, but during ambulatory BP monitoring, the BP of all 3 groups fell and indeed diastolic BP (DBP) of the hypertensives and fallers was similar during the awake period of monitoring whilst all 3 groups had similar DBP during sleep. Variability of awake and sleep BP was similar. During exercise all 3 groups sustained similar increases in systolic BP (SBP) but the increase in DBP was lower in the volunteers. Baroreflex activity was similar in all groups.

The results show little difference between the groups other than those pre-selected by casual BP measurement, and the parameters recorded reflect the process of ageing rather than specific abnormalities associated with the elderly hypertensives or fallers.

Introduction

Morbidity from cerebro-vascular accidents and recurrent falls is greater in the elderly than in a younger population. It is well documented that cardiovascular control in the elderly changes with ageing[1,2] and it is an attractive hypothesis that impaired cardiovascular control may contribute either by peaks of hypertension or hypotensive troughs to this increased morbidity.

In this study elderly hypertensives, elderly fallers and asymptomatic elderly volunteers have all undergone continuous ambulatory blood pressure monitoring[3], assessment of response to dynamic exercise and measurement of baroreflex activity and the differences between the three groups have been compared.

Methods

The study involved a total of 33 subjects divided into three groups. Nine elderly hypertensives, 6 females and 3 males of mean age 70 ± 7 years (range 60 ± 80 years) who all had casual mean BPs (MBP) greater than the 90th percentile for age using tables derived by Acheson[4]. Fifteen elderly patients with a history of recurrent unexplained falls, 9 females and 6 males of mean age 76 ± 9 years (range 63–88 years). Nine asymptomatic elderly volunteers, 4 females and 5 males of mean age 69 ± 5 years (range 63–78 years), who had casual MBPs, between the 10th and 90th percentiles for age. All subjects were in sinus rhythm and none had clinical evidence of cerebrovascular disease. No subject was taking medication likely to affect the cardiovascular system.

Subjects were hospitalized under standardized conditions and 24-h intra-arterial ambulatory BP recorded from the brachial artery of the non-dominant arm, as previously described[3]. The recording was analysed beat-to-beat by computer after periods of pressure artefact and damping had been edited[5]. Subjects recorded significant activities and the times of sleeping and waking in a diary.

During this period of ambulatory monitoring time was set aside for a period of dynamic exercise. This involved a period of rest which was followed by an accompanied walk over a set distance lasting for 15 min. The BP and HR were averaged by computer for the rest period and for the exercise.

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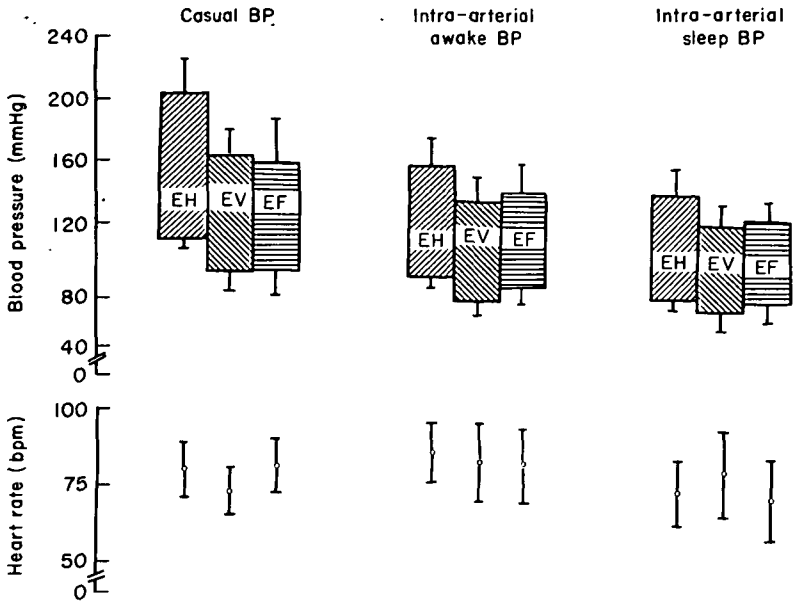

Figure 1 Casual and ambulatory BP and HR (EH = elderly hypertensive; EV = elderly volunteer; EF = elderly faller).

Prior to commencement of ambulatory monitoring, but at least 30 min after intra-arterial cannulation, assessment of baroreflex activity was performed with subjects in a supine position in a quiet room. The method used was of Smyth *et al.*[6] utilizing intra-venous bolus doses of phenylephrine and correlating the subsequent rise in SBP of individual pulse pressures with the lengthening of R–R intervals of simultaneous ECG recording.

All subjects gave informed written consent for the study which met local ethical approval.

Values are expressed as the mean ± standard deviation. The difference between means was assessed using Student's t-test.

Results

All patients underwent the study without complication.

BLOOD PRESSURE

The casual and ambulatory BPs and heart rates (HR) are shown in Fig. 1. Casual BP of the hypertensives is significantly higher than fallers or volunteers ($P<0.005$). Casual BP of the latter groups is similar.

Ambulatory awake SBP of the hypertensives is significantly higher than fallers ($P<0.05$) and of volunteers ($P<0.01$), whilst ambulatory awake DBP of the hypertensives is significantly higher than of the volunteers ($P<0.001$) but not different from the fallers. Ambulatory awake BP of volunteers and fallers was similar.

During sleep SBP of the hypertensives was significantly higher than volunteers ($P<0.01$) but was not significantly different from fallers. Sleep SBP of fallers and volunteers was similar. Sleep DBP of all 3 groups was not significantly different.

Heart rate recorded during casual recording and ambulatory monitoring was similar for all 3 groups.

The level of casual BP fell in all 3 groups when compared with awake ambulatory monitoring. The percentage fall in SBP, $-24 \pm 5\%$, and DBP, $-24 \pm 6\%$ of the hypertensives was significantly different from the fallers, SBP $-11 \pm 11\%$, DBP $-12 \pm 10\%$ ($P<0.005$). The change in the BP of the volunteers was not significantly different from either of the other groups, SBP $-17 \pm 9\%$, DBP $-21 \pm 16\%$.

VARIABILITY OF BP

The variability of BP for each patient has been defined as 1 SD of the ambulatory awake BP[7]. Variability of awake SBP and DBP for all groups was similar:

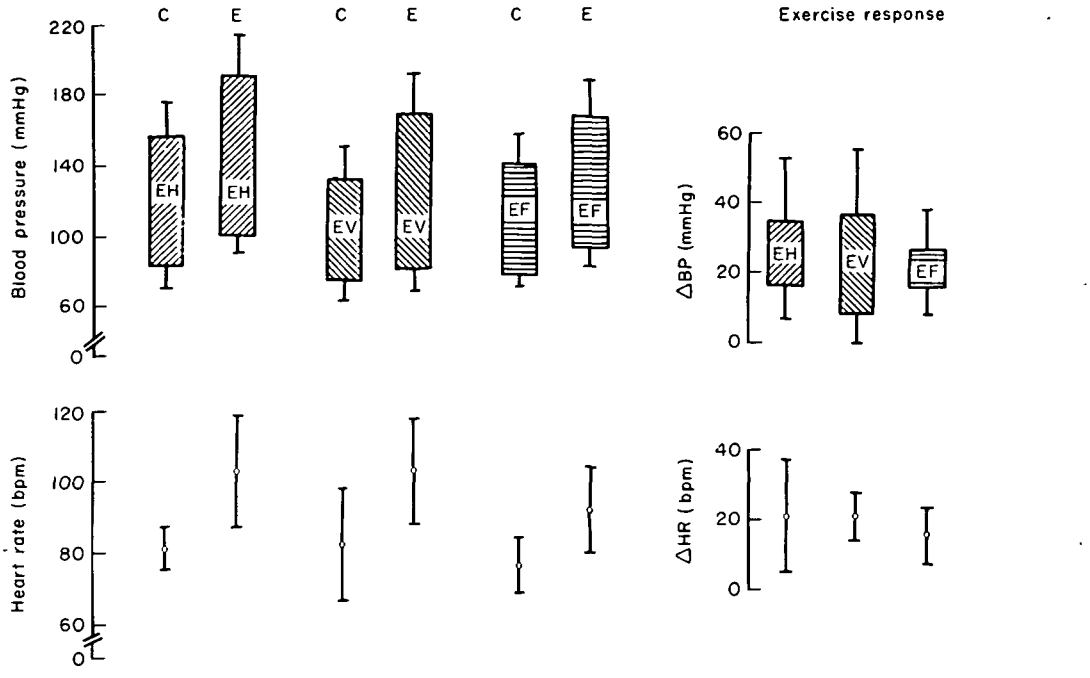

Figure 2 Blood pressure and HR response to dynamic exercise (C=control; E=exercise; other abbreviations as in Fig. 1).

$$\text{hypertensives } \frac{23\pm5}{13\pm2}\text{ mmHg;}$$

$$\text{fallers } \frac{20\pm3}{14\pm5}\text{ mmHg; volunteers } \frac{21\pm7}{12\pm4}\text{ mmHg.}$$

Variability of sleep BP was also not significantly different between groups:

$$\text{hypertensives } \frac{14\pm5}{9\pm3}\text{ mmHg;}$$

$$\text{fallers } \frac{16\pm4}{11\pm5}\text{ mmHg; volunteers } \frac{14\pm5}{9\pm3}\text{ mmHg.}$$

DYNAMIC EXERCISE

Blood pressure and HR during dynamic exercise is shown in Fig. 2. During exercise all 3 groups of elderly showed a significant increase in both SBP and DBP and also HR. When the responses of BP and HR of the groups are compared no siginificant differences are seen in response of SBP, MBP or HR between the groups, but the response of DBP was lower in the volunteers.

BAROREFLEX ACTIVITY

The mean baroreflex activity of the hypertensives was $2{\cdot}2\pm1{\cdot}4$ ms mmHg^{-1}, not significantly different from the fallers, $3{\cdot}2\pm3{\cdot}6$ ms mmHg^{-1}, nor from the volunteers, $4{\cdot}9\pm3{\cdot}6$ ms mmHg^{-1}. No significant difference existed between volunteers and fallers.

Discussion

Blood pressure recorded using this method of ambulatory monitoring in young subjects has previously been shown to be lower than casual readings[8], and in this study we have also shown this to be the case for the elderly. Indeed the degree of reduction in the elderly appears to be greater in those with higher casual levels.

During ambulatory recording variability of BP is similar for the groups both during the awake period and during sleep. It has been suggested that elderly hypertensives have a greater variability of BP[9] and this may be important in the pathogenisis of cerebrovascular accidents[10], but the results here do not support this. It is also an attractive hypothesis that elderly patients with atheromatous change in arteries supplying both brain and spinal cord may be susceptible to marked fluctuations in BP resulting in falls not necessarily associated with loss of consiousness, but again no differences in

variability were observed between fallers and the other two groups.

During dynamic exercise the three groups exhibited a significant increase in BP and HR and the responses for all groups were similar. This suggests that during exercise those subjects with higher resting BP levels are exposed to greater peaks of BP whilst those subjects with a history of falls seem able to sustain an increase in BP whilst exercising.

Baroreflex activity in the elderly has previously been shown to be impaired[11] and in this study is again low compared with what would be expected in younger subjects. Although the baroreflex activity of the hypertensives was lower than the volunteers and fallers no significant differences existed.

The results therefore show little difference between the groups other than that pre-selected by causal BP measurement, suggesting that the parameters recorded reflect the process of ageing and no specific abnormalities are associated with hypertensives and fallers.

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References

[1] Caird FI, Dall JLC, Kennedy RD. Cardiology in old age. New York: Plenum Press, 1976.

[2] Goldman R, Rockstein M. The physiology and pathology of human ageing. New York: Academic Press, 1975.

[3] Littler WA, Honour AJ, Sleight P, Stott FD. Continuous recording of direct arterial pressure and electrocardiogram in unrestricted man. Br Med J 1972; iii: 76–8.

[4] Acheson RM. Blood pressure in an national sample of US adults: Percentile distribution by age, sex and race. Int J Epidemiol 1973; 2: 293–301.

[5] Watson RDS, Stallard TJ, Littler WA. Influence of once-daily administration of β-adrenoceptor antagonists on arterial pressure and its variability. Lancet 1979; i: 1210–13.

[6] Smyth HS, Sleight P, Pickering GW. Reflex regulation of arterial pressure during sleep in man: a quantitative method of assessing baroreflex sensitivity. Circ Res 1969; 24: 109–21.

[7] Littler WA, West MJ, Honour AJ, Sleight P. The variability of arterial pressure. Am Heart J 1978; 95: 180–3.

[8] Littler WA, Honour J, Pugsley DJ, Sleight P. Continuous recording of direct arterial pressure in unrestricted patients: its role in the diagnosis and management of high blood pressure. Circulation 1975; 51: 1101–6.

[9] Coleandrea M, Friedman G, Nichaman M, Lynd CN. Systolic hypertension in the elderly: an epidemiologic assessment. Circulation 1970; 41: 239–45.

[10] Zulch KJ, Hossman V. Uber die 24-Stunden-Rhythmik des menslichen Blutdrucks. Dtsch Med Wochenschr 1967; 92: 567–72.

[11] Gribbin B, Pickering TG, Sleight P, Peto R. Effect of age and high blood pressure on baroreflex sensitivity in man. Circ Res 1971; 29: 424–31.