Influence of the postoperative period and surgical procedure on ambulatory blood pressure-determination of hypertension load after successful surgical repair of coarctation of the aorta

D. Johnson*, H. Perrault†, S. J. Vobecky‡, A. Fournier* and A. Davignon*

*Cardiology Unit, Ste-Justine Hospital; †Physical Education Department, McGill University; ‡Cardio-Thoracic Surgery Unit, Ste-Justine Hospital, Montreal, Quebec, Canada

Aims  This study quantified hypertension load using 24-h ambulatory blood pressure monitoring after successful repair of coarctation of the aorta less than (1) or more than 10 years previously (2) and examined the influence of the surgical procedure (anastomosis or subclavian flap).

Methods and Results  Ambulatory blood pressure recordings were obtained using an Accutracker II monitor every 30 min during the day and hourly, at night. Day and night systolic and diastolic values were higher in coarctation of the aorta than in controls: (day: systolic blood pressure/diastolic blood pressure: 133/71 ± 6/4 vs 115/66 ± 3/2 night: systolic blood pressure/diastolic blood pressure: 117/61 ± 4/4 vs 107/57 ± 3/2 mmHg, P < 0.01) and at all times, were higher in coarctation of the aorta (2) than in coarctation of the aorta (1). Clinical daytime systolic hypertension was observed in 20% of recordings from coarctation of the aorta (1) and 49% from coarctation of the aorta (2) while diastolic hypertension was not observed. However, systolic blood pressure and diastolic blood pressure responses to daily activities were significantly higher in coarctation of the aorta than in controls and this was more marked in coarctation of the aorta (2) than in coarctation of the aorta (1). Type of surgery did not affect either hypertension prevalence or blood pressure reactivity.

Conclusions  These observations indicate exaggerated systolic blood pressure and diastolic blood pressure reactivity after repair of coarctation of the aorta, the prevalence of systolic hypertension doubling 10 years after surgery. (Eur Heart J 1998; 19: 638–646)

Key Words: Hypertension, coarctation of the aorta, ambulatory blood pressure.

Introduction

Monitoring of arterial blood pressure following surgical correction of coarctation of the aorta has traditionally been achieved through periodic measurement of blood pressure using sphygmanometry in a clinical or medical setting. Results in the adult population generally indicate that between 20% and 30% of patients diagnosed as hypertensive on the basis of office blood pressure measurements are found to have normal blood pressure when measured at home or when evaluated by 24-h ambulatory blood pressure monitoring[1–2]. In the last 5 to 10 years, numerous reports have been published on ambulatory blood pressure monitoring of healthy and hypertensive North American and European children and adolescents[3–7]. Results generally indicate that while ambulatory blood pressure is well tolerated and provides reproducible and accurate measurements[5,8], up to 85% of adolescents diagnosed with diastolic hypertension and up to 70% diagnosed with systolic hypertension on the basis of office blood pressure determination may be found to have daytime ambulatory blood pressure readings below 90 mmHg and 140 mmHg, respectively[9].

Despite apparently successful surgical repair of coarctation of the aorta, 10–40% of patients examined 10 to 20 years after surgery are found to be hypertensive on the basis of 'office' blood pressure measurements[10–12]. There exists, however, only limited...
data on the characterization of daily arterial blood pressure variations using ambulatory blood pressure monitoring in patients operated on for coarctation of the aorta [13, 14] and neither of these studies was designed to quantify the extent of blood pressure load in patients after successful repair of coarctation. Results from Leandro et al. [13] indicated no difference in diastolic blood pressure between healthy age-matched adolescents and patients examined 4 to 14 years after primary surgical repair, but significantly higher systolic blood pressures both day and night in male patients and during sleep only in female patients. In the study by Parrish et al. [14], reporting on the relationship between recurrent aortic narrowing and elevation of blood pressure in a group of adolescents with apparently good results from surgical repair of aortic coarctation, a greater prevalence of 24-h recordings above the 95th percentile value was found in patients (18%) than controls (7%), although no significant differences in the ‘awake’ or ‘asleep’ mean blood pressure values were observed. The mean follow-up period in both of these studies remained at or lower than 10 years. Considering that an increase in the incidence of hypertension is generally found with longer follow-up periods [15–17] and that results from actuarial analyses generally show significantly lower recoarctation recurrence rates with the subclavian flap angioplasty technique than with the original end-to-end repair procedure [15, 18–21], the discrepancy in findings may be related to differences in the duration of the post-surgical period and the type of corrective surgery.

The present study was designed to characterize the extent of daytime and night-time hypertension load using 24-h ambulatory blood pressure measurements, in normotensive patients who have undergone primary repair of coarctation in early childhood and selected to have no arm–leg gradient and no echocardiographic evidence of recoarctation. In addition, we examined the influences of the duration of the post-surgical period and of the type of surgical procedure on the circadian variations of systolic blood pressure and diastolic blood pressure as well as on the extent of hypertension load and blood pressure reactivity.

**Methods**

**Recruitment procedure and study population**

Patients were recruited from a cohort of children followed regularly in our paediatric cardiology unit. Subjects old enough to provide full cooperation with ambulatory monitoring and meeting inclusion criteria characteristics were invited on a voluntary basis to participate in the study during a follow-up visit. Inclusion criteria were: (a) absence of associated intra-cardiac defects or signs of aortic restenosis, as determined by physical examination; (b) arm–leg pressure gradient less than 15 mmHg; (c) normal electrocardiographic and echocardiographic parameters; (d) normal office blood pressure values. A sample of 21 patients (17 boys and four girls) showing successful correction of coarctation of the aorta were investigated. Mean age at investigation was 15.2 ± 4.2 years (mean ± SD) (range: 5.6–22.7 years).

The operation had been carried out at a mean age of 5.5 ± 4.6 years, resulting in a mean post-surgical delay of 9.4 ± 4.9 years. Surgical repair was performed through left subclavian flap angioplasty in nine patients and end-to-end anastomosis in 12. For comparison purposes, a group of 20 healthy adolescents recruited on a voluntary basis from local schools and friends of patients were also evaluated and screened for any known health problems (12 boys and eight girls, age: 19.6 ± 5.3 years). The project was approved by the ethics review board of our institution, and informed consent to participate in the study was obtained by all participants and their parents or guardian for subjects younger than 18 years of age.

**Evaluation and measurements**

**Office blood pressure**

Office blood pressure measurements were taken using a Dinamap sphygmomanometer after a 15 min sitting rest period. Because the first Dinamap reading has been shown to be different from the other successive measurements, the average of the last two of three consecutive readings is reported. The 24 h ambulatory blood pressure monitor was installed following the office blood pressure evaluation. Measurements were obtained from the right arm in all patients, care being taken to use an appropriate cuff size, with a width two-thirds of the upper arm circumference.

Twenty-four hour blood pressure and heart rate

Twenty-four hour ambulatory blood pressure and heart rate measurements were made using an automatic non-invasive device (Suntech Model 104, Acurrater II) that uses an auscultatory method for the detection of R-wave gating systolic and diastolic (phase 5 K or rorokoff sounds) blood pressures.

Measurements were made at 30-min intervals between 0700 h and 2300 h and at 60 min intervals between 2300 h and 0700 h. Patients were encouraged to go about their usual daily activities, to relax their arm during cuff inflation and deflation but to avoid strenuous physical activity. Ambulatory blood pressure monitoring was always performed on a schoolday to standardize activity patterns. Subjects kept an activity diary that included the amount of time they slept or exercised. All studies were performed with the display monitor off to avoid anticipation of the blood pressure readings by subjects. After the 24-h recording, data were downloaded and printed on a Suntech Model 10411 report printer and all values of systolic and diastolic blood pressures, as well as heart rate, recorded over the 24-h period were analysed. The ambulatory blood pressure monitoring profile was accepted only if a total
of 32 readings or more, out of the potential total of 40 recordings, were captured during the study period. Criteria for deleting individual blood pressure readings included a pulse pressure <20 mmHg or an inconsistent >50 mmHg increase, or a decrease in systolic and pulse pressure or >40 mmHg increase or decrease in diastolic blood pressure from a previous reading. The total percentage of recorded sample was 82%.

**Ambulatory blood pressure data analysis**

For each subject, an average hourly blood pressure was calculated from single recordings. Hourly values for all patients or control subjects were averaged to produce a daytime (0700 h to 2259 h) and a night-time (2300 h to 0659 h), as reflected from individual records of bedtime and rising, or an overall 24-h group mean. Similarly, variations in systolic and diastolic blood pressure (mmHg) were plotted against a 24-h period scale using 0 as the baseline y-value for computation of the total surface area under each curve for each subject, and means and standard variations were calculated for each group as an index of blood pressure load for a given area over the 24-h period (Fig. 1), systolic and diastolic pressure readings exceeding 140/90 mmHg during the awake period, and 120/80 mmHg during the sleeping period[22]. Group hypertension prevalence was also calculated, as the number of subjects per group showing daytime or night-time mean values exceeding these critical limits. Because these criteria for calculating hypertension load are applicable mainly to the adult population, hypertension prevalence was also computed using the critical limits of 136/86 mmHg reported for adolescents between 13 and 15 years of age, as given in the report of the Second Task Force on Blood Pressure Control in Children, 1987[23]. Because age-adjusted blood pressure critical limits are not available for nighttime, the prevalence of systolic and diastolic hypertension was only determined using this criteria for daytime.

Blood pressure ‘reactivity’ to daytime activities was calculated for each subject as the difference between the mean systolic or diastolic blood pressure values obtained at midnight and the corresponding mean value at 0900 h, 1200 h, 1500 h, 1800 h and 2100 h. For each subject, the reactivity was obtained as the average blood pressure value at any given selected time minus the average blood pressure at midnight. Individual values of reactivity were averaged over all subjects for purposes of group comparisons.

**Group comparisons**

A posteriori breakdown in patients according to the duration of the post-surgery interval was achieved using a classification criteria of 10 years. Group 1 (coarctation of the aorta (1)) was composed of patients with a post-surgical period of less than 10 years while group 2 (coarction of the aorta (2)) consisted of patients with a post-surgical period greater or equal to 10 years. Pooled data from all patients were also analysed according to type of surgery, i.e. left subclavian flap angioplasty or end-to-end anastomosis.

**Statistical analyses**

All dependent variables are expressed as mean ± SD. Students’ t-tests were used for comparison of the mean 24-h as well as daytime and night-time average values, or computed surface areas for systolic, diastolic and mean arterial blood pressures between controls and patients. A three-way (3 × 24) analysis of variance (ANOVA) for repeated measures on the last factor was performed for the main effects of groups (controls vs coarctation of the aorta (1) vs coarctation of the aorta (2)) and time. Upon finding a significant main group or time effect, the LSD multiple range test was used for further post-hoc comparisons. Statistical analyses were performed using SAS (Statistical Analysis System, SAS Institute, Cary, NC, U.S.A.) statistical packages. Statistical significance was set at P <0·05.

**Results**

Subjects anthropometric characteristics are shown in Table 1. There was no significant difference in weight, height or body surface area between coarctation of the aorta patients and control subjects, although patients in coarctation of the aorta (1) were significantly younger, lighter and had a lower body surface area than controls. Age at surgery was significantly higher in coarctation of the aorta (1) than coarctation of the aorta (2) and as expected, the post-surgery interval was significantly higher in coarctation of the aorta (2) (13·4 ± 1·9 years) than in coarctation of the aorta (1) (5·1 ± 3·1 years).

Office and the average of the 24-h systolic and diastolic blood pressure measurements were generally similar in both patients and controls, although office values tended to be higher than ambulatory blood pressure values in control subjects (Table 2). Examination of the influence of the sex of the patient on blood pressures revealed no significant gender effect, thus allowing male and female data to be pooled. As seen in Table 2 as well as from calculated blood pressure surface areas over the 24-h period (Fig. 1), systolic and diastolic blood pressure and mean arterial pressure and heart rate were significantly higher in coarctation of the aorta patients compared to control subjects during both awake and asleep periods, although mean values remained within the range of clinical normality[23]. When values from patients were further subdivided into groups, coarctation of the aorta (2) showed significantly higher average 24-h systolic and diastolic blood pressure.
Table 1  Anthropometric characteristics of subjects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ctrl (n=20)</th>
<th>CoAo (n=21)</th>
<th>CoAo (1) (n=10)</th>
<th>CoAo (2) (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (f/m)</td>
<td>8/12</td>
<td>4/17</td>
<td>2/8</td>
<td>2/9</td>
</tr>
<tr>
<td>Age (years)</td>
<td>19 ± 5.3</td>
<td>15.2 ± 4.2**</td>
<td>13.4 ± 4.5**</td>
<td>16.8 ± 3.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>62.4 ± 15.9</td>
<td>52.9 ± 18.7</td>
<td>46.8 ± 19.6*</td>
<td>50.6 ± 16.7</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.7 ± 0.1</td>
<td>1.6 ± 0.2</td>
<td>1.52 ± 0.17†</td>
<td>1.68 ± 0.14</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.73 ± 0.34</td>
<td>1.56 ± 0.32</td>
<td>1.44 ± 0.33*</td>
<td>1.66 ± 0.29</td>
</tr>
<tr>
<td>Age at surgery (years)</td>
<td>—</td>
<td>5.5 ± 4.9</td>
<td>7.9 ± 5.0‡</td>
<td>3.4 ± 3.0</td>
</tr>
<tr>
<td>Post-surgical interval (years)</td>
<td>—</td>
<td>9.4 ± 4.9</td>
<td>5.1 ± 3.1‡</td>
<td>13.4 ± 1.9</td>
</tr>
<tr>
<td>Type of surgery (no. LSF/ETE)</td>
<td>—</td>
<td>9/12</td>
<td>1/9</td>
<td>8/3</td>
</tr>
</tbody>
</table>

Values are mean ± SD.

BSA = body surface area; LSF = left subclavian flap angioplasty; ETE = end-to-end anastomosis.

*P < 0.05 significantly different from controls; **P < 0.01 significantly different from controls; †significantly different from control and CoAo (2); ‡significantly different from CoAo (1).

Table 2  Blood pressure evaluation in controls and patients according to post-surgical interval

<table>
<thead>
<tr>
<th>Groups</th>
<th>SBP 24-h (average) (mmHg)</th>
<th>DBP 24-h (average) (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CoAo (1)</td>
<td>124 ± 12</td>
<td>65 ± 15</td>
</tr>
<tr>
<td>CoAo (2)</td>
<td>130 ± 9</td>
<td>69 ± 10</td>
</tr>
</tbody>
</table>

Values are mean ± SD.

SBP = systolic blood pressure; DBP = diastolic blood pressure.

*P < 0.05 significantly different from control; **P < 0.01 significantly different from control; †P < 0.01 significantly different between CoAo (1) and CoAo (2).

as well as higher systolic and diastolic blood pressure surfaces than both coarctation of the aorta (1) and controls during the awake period. Significantly higher systolic and diastolic blood pressure surfaces were also found in coarctation of the aorta (2) than in control subjects during sleeping. A significant decrease in systolic and diastolic blood pressure was observed from the awake to the sleeping period in all subjects, the relative night-time fall in mean systolic and diastolic blood pressure being 6 ± 4% and 11 ± 7%, respectively, in control subjects, 9 ± 6% and 10 ± 7% in coarctation of the aorta (1) and 15 ± 4% and 17 ± 6% in coarctation of the aorta (2).

Data analysis for type of surgery indicates no significant difference in average 24-h systolic or diastolic blood pressure, heart rate values (Table 3) or blood pressure surface areas over 24 h, daytime or night-time, between patients operated on using end-to-end anastomosis or using the subclavian flap procedure, but confirm the observations of higher systolic and diastolic blood pressure and heart rate in patients than controls independent of the type of surgery.

Calculated hypertension loads, using the traditional criteria of either 140/90 mmHg for daytime or 120/80 for night-time threshold values and using 136/86 mmHg as recommended for adolescents in the Report of the Second Task Force on Blood Pressure Control in Children, 1987[23], are shown in Table 4, for both the number of subjects per group and the number of ambulatory blood pressure readings exceeding the threshold value. Results indicate little prevalence of diastolic hypertension if any, while calculated prevalences of systolic hypertension in patients during both the awake and the asleep periods range between 29% and 49%, using the standard day and night adult criteria, and between 38% and 57% using the daytime adolescent critical limit. During the awake period, 29% (6/21) of patients showed systolic hypertension which could mainly be accounted for by a 45% prevalence (5/11) in coarctation of the aorta (2) subjects. Corresponding values for night-time prevalences are 29% for all patients, 20% for coarctation of the aorta (1) and 36% for coarctation of the aorta (2). Prevalences of systolic hypertension calculated using the number of readings exceeding the threshold values are slightly higher than those found using the number of subjects per group. The overall prevalence is 35% in patients during the awake period and 40% during sleep, when using the standard adult criteria, and 43% in patients during the awake period using the adolescent threshold value, compared...
to 2% in controls. Using either set of criteria, the comparison of prevalences of daytime systolic hypertension between coarctation of the aorta (1) and coarctation of the aorta (2) shows a more than doubling of both the systolic and the diastolic hypertension load in coarctation of the aorta (2) compared to coarctation of the aorta (1).

Figure 2 illustrates blood pressure reactivity to daytime tasks, through computation of differences in blood pressure between the midnight value and that at selected times throughout the day. Recorded changes in systolic blood pressure during daytime activities were significantly higher in patients than controls. Results also show evening systolic reactivity (between 1800 h and 2400 h) to be significantly higher in coarctation of the aorta (2) than in coarctation of the aorta (1). In the coarctation of the aorta (1) group, a systolic reactivity significantly higher than that of controls was only seen at 1200 h. Coarctation of the aorta (2) also showed significantly higher diastolic blood pressure reactivity than coarctation of the aorta (1) at 1200 h and 1800 h, but diastolic blood pressure reactivity was similar in coarctation of the aorta (1) and controls at any period. Heart rate reactivity was similar in all groups.

**Discussion**

Results from the present investigation demonstrate that despite normal office blood pressure, patients successfully operated on in early childhood for coarctation of the aorta exhibit higher systolic and diastolic blood pressure loads than controls during both daytime and night-time. The prevalence of daytime and night-time systolic hypertension is more than doubled in patients with a post-surgical interval greater than 10 years. In these patients, an exaggerated systolic pressure response to daily tasks was observed compared to controls or to patients with a shorter post-surgical delay. These observations appear independent of the type of surgical repair, which was not found to significantly affect the blood pressure reactivity profile or the overall prevalence of hypertension after surgical repair of coarctation.

**Office vs ambulatory blood pressure determinations**

Examination of office blood pressure determinations showed systolic blood pressure to be in excess of the threshold value of 136 mmHg (recommended for ages 13–15 years) in 27% of patients from the coarctation of the aorta (2) group as compared to 0 in healthy controls. This prevalence of systolic hypertension is in agreement with the 10–50% hypertension statistics generally reported in long-term follow-up of patients operated on for coarctation of the aorta, but which also includes patients with recoarctation or associated cardiac and non-cardiac anomalies. In the present study, patients were selected if they were free of restenosis and led a normal active life, which may account for the lower prevalence observed. On the other hand, the prevalences of systolic and diastolic hypertension calculated using ambulatory blood pressure were approximately twice those calculated for office measurements, whether considering the number of subjects showing values above the critical limit or the number of blood pressure readings exceeding this criteria (Table 4). Because daytime
determinations are not necessarily taken under resting conditions, but may be obtained during mild or moderate physical activities, an increase in blood pressure load may to some extent be predictable when using ambulatory blood pressure\(^5\). In the present study, ambulatory monitoring was conducted during a normal school day to standardize for physical activity; none of the subjects took part in regular physical training. Examination of the activity diaries revealed no differences in the daytime activity pattern and similar ranges of daytime heart rates were observed in both groups, suggesting similar activity patterns. It is thus unlikely that the higher prevalence of hypertension found using ambulatory monitoring results from differences in activity patterns. The fact that the prevalence of systolic hypertension also remained higher in patients during the night-time period also suggests that physical activity is not a factor.

### Influence of post-surgical interval on hypertension prevalence

The overall prevalence of systolic hypertension in patients was mostly attributed to patients from the coarctation of the aorta (2) group, the prevalence of systolic hypertension being at least twice as high in these patients than in those from coarctation of the aorta group (1). Results from long-term comparisons of patients operated on for coarctation of the aorta generally indicate an increase in the prevalence of hypertension as the duration of the post-surgical interval increases\(^15–17\). The selection of a 10-year critical follow-up period used in the present study was based on previous observations showing a marked increase in the hypertension prevalence with periods of 10 years or more\(^17\). In patients exhibiting a number of associated lesions favourable to the development of hypertension, Clarkson et al.\(^17\), reported a prevalence of hypertension of 25%, using a critical limit for hypertension of 160/95 mmHg, despite the fact that more than half the patients were younger than 40 years of age. The markedly higher prevalence found in the present study could be attributed to our selection of a lower critical limit as well as to the use of ambulatory blood pressure, accounting for a higher number of readings and a potentially higher probability of identifying values in excess of the critical limit.

Night-time was associated with a fall in blood pressure equivalent to 7% for systolic and 12% for diastolic pressure in control subjects, which is in agreement with previous reports in young healthy subjects\(^5\). The night-time fall was significantly larger in patients with the longer follow-up interval, values reaching 15% for systolic blood pressure and 17% for diastolic blood pressure, which is in accordance with previous reports in patients with essential hypertension\(^24\). This observation is also compatible with the greater blood pressure reactivity to daily tasks found in patients of the coarctation of the aorta (2) group. A clear explanation for the higher prevalence of hypertension with longer postoperative intervals has not yet been provided. A decrease in vascular resistance and in vascular reactivity of vascular beds supplied by arteries originating from the portion of the aorta proximal to the coarctation has been described in normotensive post-coarctectomy patients\(^26–28\). This could be related to alterations in vascular smooth muscle and collagen content\(^29\) or vascular endothelium properties\(^30,31\). In addition, an increase in aortic stiffness of the transverse aortic arch\(^32\) as well as in the rigidity of the pre-coarctational aortic wall have been reported\(^29\). This could contribute to a disturbance in the baroreflex control of arterial blood pressure\(^33\). The present observation, that heart rate was not significantly affected in patients despite exaggerated blood pressure responses, may be compatible with a decrease in baroreflex sensitivity, as previously demonstrated by Beekman et al.\(^33\) 7 years after childhood repair of coarctation of the aorta. These histological and functional alterations could thus contribute to the acceleration of the appearance of the age-related changes in arterial blood pressure and account for an increasing prevalence of hypertension with longer post-operative intervals.

### Influence of surgical approach in the etiology of hypertension

Because subclavian flap angioplasty results in low rates of recurrence of coarctation\(^15,19,20\), it had been

---

**Table 3  Blood pressure values in controls and patients according to type of surgery**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Systolic blood pressure</th>
<th>Diastolic blood pressure</th>
<th>Heart rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A wake (mmHg)</td>
<td>A sleep (mmHg)</td>
<td>24-h (average) (mmHg)</td>
</tr>
<tr>
<td>Controls</td>
<td>115±11</td>
<td>107±12†</td>
<td>112±12</td>
</tr>
<tr>
<td>LSF</td>
<td>135±20**</td>
<td>116±14**†</td>
<td>128±20**</td>
</tr>
<tr>
<td>ETE</td>
<td>131±19**</td>
<td>116±16**†</td>
<td>126±19**</td>
</tr>
</tbody>
</table>

Values are mean ± SD.
LSF = left subclavian flap; ETE = end-to-end anastomosis.
†P < 0.01 significantly different from awake; *P < 0.05 significantly different from controls; **P < 0.001 significantly different from controls.
## Table 4  Incidence of daytime and night-time hypertension load using traditional criteria and the STFH criteria

<table>
<thead>
<tr>
<th>Groups</th>
<th>Systolic blood pressure</th>
<th>Diastolic blood pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Awake</td>
<td>Asleep</td>
</tr>
<tr>
<td></td>
<td>Sub./tot.</td>
<td>Incidence (%)</td>
</tr>
<tr>
<td>Traditional criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0/20</td>
<td>0</td>
</tr>
<tr>
<td>Patients</td>
<td>6/21</td>
<td>29</td>
</tr>
<tr>
<td>CoAo (1)</td>
<td>1/10</td>
<td>10</td>
</tr>
<tr>
<td>CoAo (2)</td>
<td>5/11</td>
<td>45</td>
</tr>
<tr>
<td>STFH criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0/20</td>
<td>0</td>
</tr>
<tr>
<td>Patients</td>
<td>8/21</td>
<td>38</td>
</tr>
<tr>
<td>CoAo (1)</td>
<td>2/10</td>
<td>20</td>
</tr>
<tr>
<td>CoAo (2)</td>
<td>6/11</td>
<td>55</td>
</tr>
</tbody>
</table>

Traditional criteria=SBP hypertension load=(awake SBP >140 mmHg and asleep SBP >120 mmHg)/total number of readings in 24 h; DBP hypertension load=(awake DBP >90 mmHg and asleep DBP >80 mmHg)/total number of readings in 24 h; STFH criteria=Second Task Force hypertension[23]; 136/86 mmHg applicable only to the awake period. Values are mean ± SD; *P<0.05 from controls; †P<0.001 from CoAo (1) and controls.
suggested that this type of surgical procedure could lead to the lower prevalence of development of late hypertension. However, recent results obtained after a median follow-up period of 57 months showed the prevalence of hypertension to be independent of surgical technique in children operated on at a median age of 2 months[34]. In agreement with the latter finding, the present study indicates that the type of surgical procedure has no influence on either daytime or night-time blood pressure profiles, or on the prevalence of hypertension (22% subclavian angioplasty vs 17% end-to-end anastomosis) upon re-examination some 10 years postsurgery. It may be argued that because recurrence of coarctation was an exclusive criteria for the present study, potentially more patients operated on through a given procedure might have been excluded from participation. On the other hand, in their investigation of 3-year-old children operated on after 3 months of age, Sciolaro et al.[21] found a greater prevalence of hypertension following end-to-end anastomosis than subclavian flap angioplasty, although recurrence of coarctation was not different between surgical procedures. Moreover, since the present results indicate an increase in the prevalence with the longer post-operative interval in the absence of any evidence of re-coarctation, it may be suggested that factors other than recurrence of coarctation may be involved in defining the prevalence of post-operative hypertension.

In conclusion, the present results indicate that independent of the surgical procedure, patients successfully operated on for coarctation of the aorta show significantly higher systolic and diastolic blood pressures than healthy controls, the prevalence of hypertension increasing markedly with the longer post-operative interval. Considering that findings of exaggerated ambulatory blood pressure responses may be predictive of the development of a chronic hypertension state[35,36], these results may be taken to suggest close monitoring of patients operated on for coarctation of the aorta despite their good clinical status.

**References**


