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Ageing, obesity, dyslipidaemia, and hospital-room hypertension are clinical risk factors relating to pre-anaesthesia hypertension

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Abstract

Background: Pre-anaesthesia hypertension (PAH) occurs when the blood pressure (BP) in patients before surgery, in the operating room, before anaesthesia induction, temporally elevates regardless of normal ambulatory recorded BP or self-measured BP at home. PAH might be caused by anxiety and mental stress about the anaesthesia and surgery. We know that most of the patients with sustained hypertension (SH) are elders, males, obese subjects, and dyslipidaemic subjects. Furthermore, most of the patients with white coat hypertension, which is caused by mental stress about the medical environment of an outpatient, clinic, and hospital ward, are elders, females, and non-smokers. In the present study, we investigated some relevant clinical characteristics influencing PAH.

Methods: Sampling data on patients more than 20 years old, who underwent consecutive operations under general, intrathecal, or epidural anaesthesia were retrospectively collected from hospital records and anaesthesia records. Hospital-room hypertension (HH) was defined as systolic BP (sBP) greater than or equal to 140 mm Hg in the hospital room before anaesthesia and surgery. Operating-room hypertension (OH) was defined as sBP greater than or equal to 140 mm Hg in the operating room before anaesthesia induction.

Results: 112 and 119 patients belonged to the OH and operating-room normotension (ON) groups, respectively. The OH group members were significantly older than the ON group members. Body mass index in the OH group was significantly greater than in the ON group. The proportions of males, dyslipidaemic subjects, and non-smokers in the OH group were significantly higher than in the ON group. In the logistic regression analysis, age, body mass, dyslipidaemia, and HH were selected as significant factors that contribute independently to OH (odds ratios; 1.045, 1.031, 2.912, and 4.354, respectively).

Conclusions: The clinical characteristics of the patients with OH are: elders, obese subjects, dyslipidaemic subjects, and hospital-room hypertensive subjects. Ageing, obesity, dyslipidaemia, and HH are clinical risk factors relating to PAH.

Key words: before anaesthesia induction, surgery, systolic blood pressure, operating-room hypertension, body mass index.

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INTRODUCTION

We often observe that blood pressure (BP) in patients awaiting anaesthesia and surgery in the operating room temporally elevates regardless of the patient's normal ambulatory recorded BP or self-measured BP at home. The phenomenon is called pre-anaesthesia hypertension (PAH) or pre-induction hypertension [1, 2]. We speculate that it is caused by anxiety and mental stress about the anaesthesia and surgery.

In sustained hypertension (SH), BP measurements taken both in the doctor's office and at home are elevated. We know that most of the patients with SH are elders, males, obese subjects, and dyslipidaemic subjects. The clinical characteristic of SH in the elderly is a significant increase in systolic BP (sBP).

The prevalence of not only SH, but also of diabetes mellitus (DM) and ischaemic heart disease (IHD) generally increase progressively with age. Furthermore, syndrome X, also known as metabolic syndrome or insulin resistance syndrome, is a combination of SH, insulin resistance or DM, dyslipidaemia, and central obesity.

White coat hypertension (WCH), also called isolated office hypertension or isolated clinic hypertension, is a phenomenon in which patients exhibit elevated BP in a clinical setting but not in other settings [3, 4]. It is believed that this is due to the anxiety that some people experience during a clinic or hospital visit. Some studies report that WCH is associated with hyperactivity to mental stress [5, 6], standing stress [6], and sympathetic nerve [7]. Because mental stress [8], time urgency, impatience, and hostility [9] have been reported to be independent risk factors in the development of SH, it is possible that a higher reactivity to stress in medical environments leads to WCH. Therefore, mental activities such as emotion, defence response to the medical staff, e.g. the doctor and nurse, medical circumstances, and conditional reflex may affect WCH. We know that most of the patients with WCH are elders, females, and non-smokers. We speculate that mental stress about the medical environment of the operating room is greater than that of the outpatient clinic or hospital ward. Furthermore, we speculate that PAH is caused by a greater degree of anxiety and mental activity than WCH.

Therefore, it is useful and worthwhile to interpret some relevant clinical characteristics influencing PAH. We have already reported that the difference between sBP in the hospital room before operation and sBP in the operating room before anaesthesia induction (ΔsBP) increases with ageing [1]. In the present study, we investigated the clinical characteristics of patients with PAH.

METHODS

Study population

Sampling data on patients over 20 years old, who underwent consecutive operations under general, intrathecal, or epidural anaesthesia, were retrospectively collected from hospital records in the hospital ward and anaesthesia records in the operating room at Teikyo University Hospital in May and June 2008. The patients with SH, who were defined as patients with past history of hypertension and taking oral antihypertensive medications, and patients with arrhythmias on ECG were excluded from the data. The sBP, diastolic BP (dBP), and heart rate values in patients during resting and lying on the bed in the hospital room were measured once with automatic BP machines operated by nurses, and were recorded in steps of 1 mm Hg or 1 beat per min in hospital records. The duration of nothing *per os* (NPO) before elective surgery of patients was more than eight hours. Patients did not take any premedication. Patients walked into or entered the operating room on stretchers or wheelchairs. Electrocardiogram (ECG) monitors were equipped, and arterial BP cuffs were positioned on the upper arms of the patients, who rested on the operating tables for three minutes because WCH persists during the first four minutes during the doctor's visit, disappearing within about 10 minutes [10]. The sBP and dBP values were measured once with automatic BP machines, and the heart rate values were measured with ECG monitors. The sBP and dBP values were recorded in steps of 5 mm Hg, and the heart rate values were recorded in steps of 5 beats per min in anaesthetic records.

Definition of normotension and hypertension

In the present study, normotension was defined as sBP lower than 140 mm Hg, and hypertension was defined as sBP higher than or equal to 140 mm Hg. We named the normotensive patients in the hospital room before entering the operating room "hospital-room normotension" (HN) and hypertensive patients in the hospital room "hospital-room hypertension" (HH). Similarly, we named the normotensive patients in the operating room before anaesthesia induction "operating-room normotension" (ON) and the hypertensive patients in the operating room "operating-room hypertension" (OH).

In addition, the objective patients were classified into four groups as the standard of sBP in both the hospital room and operating room. The first group comprised the normotensive patients in the hospital room and the normotensive patients in the operating room, named the "HN/ON group". The second group comprised the hypertensive patients in the hospital room and the normotensive patients in the operating room, named the "HH/ON group". The third group comprised the normotensive patients in the hospital room and the hypertensive patients in the operating room, named the "HN/OH group". The fourth group comprised the hypertensive patients in the hospital room and the hypertensive patients in the operating room, named the "HH/OH group".

Host-related factors

For each patient, we collected data on age, gender, height, body mass, body mass index (BMI), sBP, dBP, and heart rate in the hospital room, heart rate in ECG in laboratory, sBP, dBP, and heart rate in the operating room, smoking, drinking, past history of DM, dyslipidaemia, IHD, respiratory disease, brain disease, mental disease, renal failure, hyperuricaemia, operation, and treatment with uricosuric drugs and hypolipidemic drugs.

IHD included coronary heart disease and myocardial ischaemia. Smokers were defined as those who smoked currently, and regularly for at least the last year. In spite of heavy and light drinkers, we classified them as drinkers.

Statistical analysis

Un-paired *t*-test and one-way ANOVA and post hoc test with Scheffe test were used for comparison of age, height, body mass, BMI, sBP, dBP, and heart rate. The χ^2 test was used for comparison of gender, DM, dyslipidaemia, past history of IHD, smoking, and drinking.

Univariate analysis was performed using the χ^2 test between the OH and ON groups. Multivariate analysis was performed using logistic regression. Parameters that were significantly different in the univariate analysis between the two groups were entered into the multivariate analysis. Significant independent variables contributing to OH were extracted using stepwise selection methods. The odds ratios of the selected factors were compared and scored as integers.

SPSS 16.0vJ (SPSS, Chicago, Illinois, USA) was used as statistical software. The values were expressed as the mean ± standard deviation (SD) unless otherwise stated. A *P* value of < 0.05 was considered to indicate statistical significance.

RESULTS

Study population

The total data of 365 patients (188 males and 177 females) were collected. The age was 55.9 ± 16.6 (minimum 20 – maximum 90) years. 121 patients with SH and seven patients with atrial fibrillation on ECG were excluded from the data. 109 patients of the 121 patients with SH took oral antihypertensive drugs: calcium channel blocker (66), angiotensin II receptor blocker (59), diuretics (15), β blocker (13), angiotensin-converting enzyme inhibitor (9), and α blocker (6). Moreover, six patients with missing or incomplete data values of hospital records and anaesthesia records were deleted from the data: sBP values in the operating room (3), sBP values in the hospital room (2), and pre-operative medical history (1).

Therefore, the remaining data of 231 patients were used for analyses. The patients belonged to departments of orthopaedic surgery (59), general surgery (38), otorhinolaryngology (28), urology (26), gynaecology (25), plastic surgery (18), obstetric surgery (12), oromaxillofacial surgery (6), neurosurgery (4), ophthalmology (4), psychiatry (3), emergency (3), dermatology (2), cardiac surgery (1), thoracic surgery (1), and anaesthesiology (1). They had no cardiac or vascular events in the peri-operative period.

Hospital-room hypertension (HH)

Clinical characteristics of the HN (211) and HH (20) groups are shown in Table 1. The HH group members were significantly older than the HN group members. The HH group members were significantly heavier than the HN group members. The BMI in the HH group was significantly greater than in the HN group. The rate of dyslipidaemic subjects in the HH group was significantly higher than in the HN group.

Operating-room hypertension (OH)

Clinical characteristics of the ON (119) and OH (112) groups are shown in Table 2. The OH group members were significantly older than the ON group members. The ratio of males to females in the OH group was significantly higher than in the ON group. The BMI in the OH group was significantly greater than in the ON group. The rate of dyslipidaemic subjects in the OH group was significantly higher than in the ON group. The rate of non-smokers in the OH group was significantly higher than in the ON group.

Four groups (HN/ON, HH/ON, HN/OH, and HH/OH)

Clinical characteristics of the HN/ON (116), HH/ON (3), HN/OH (95), and HH/OH (17) groups are shown in Table 3. The HN/OH and HH/OH group members were significantly older than the HN/ON group members. The ratios of males to females in the HH/ON and HN/OH groups were significantly higher than in the HN/ON group. The HH/ON group members were, on average, significantly heavier than the HN/ON, HN/OH, and HH/OH group members. The BMI in the HH/ON and HH/OH groups were significantly greater than in the HN/ON group, and the BMI in the HH/ON group was significantly greater than in the HN/OH group. The rates of dyslipidaemic subjects in the HN/OH and HH/OH groups were significantly higher than in the HN/ON group. The rate of IHD in the HH/ON group was significantly higher than in the HN/ON, HN/OH, and HH/OH groups.

Univariate analysis

In univariate analysis, the OH group included more patients who were older, male, had greater BMI, higher sBP in the hospital room, higher dBP in the hospital room, HH, higher sBP in the operating room, higher dBP in the operating room, faster heart rate in the operating room, and past history of dyslipidaemia, than the ON group. More patients were taking hypolipidemic drugs in the OH group.

TABLE 1. Characteristics of the HN and HH groups

Parameter	HN ($n = 211$)	HH ($n = 20$)
sBP in hospital room (mm Hg)	116.5 ± 11.6	146.5 ± 8.6**
sBP in operating room (mm Hg)	137.8 ± 27.7	161.8 ± 21.5**
dBP in hospital room (mm Hg)	68.4 ± 10.6	82.6 ± 13.6**
dBP in operating room (mm Hg)	78.7 ± 16.4	92.8 ± 17.7**
Heart rate in hospital room (beats per min)	74.5 ± 9.9 ($n = 203$)	78.7 ± 17.3 ($n = 19$)
Heart rate in operating room (beats per min)	78.1 ± 14.6 ($n = 206$)	78.4 ± 12.7 ($n = 19$)
Age (years)	49.7 ± 16.4	57.7 ± 14.5*
Male/Female (*n*/*n*)	91/120	11/9
Height (cm)	161.9 ± 9.0 ($n = 207$)	162.4 ± 9.9
Body mass (kg)	58.7 ± 11.9 ($n = 209$)	67.4 ± 16.1*
BMI (kg m^{-2})	22.4 ± 3.6 ($n = 207$)	25.4 ± 5.0**
DM/Non-DM (*n*/*n*)	17/194	1/19
Dyslipidaemia/Non-dyslipidaemia (*n*/*n*)	9/202	4/16**
Past history of IHD/Non-IHD (*n*/*n*)	2/209	1/19
Smoker/Non-smoker (*n*/*n*)	73/124 ($n = 197$)	7/11 ($n = 18$)
Drinker/Non-drinker (*n*/*n*)	88/106 ($n = 194$)	9/9 ($n = 18$)

Data given as mean ± SD or numbers. *$P < 0.05$, **$P < 0.01$ vs. HN group

HN — hospital-room normotension, HH — hospital-room hypertension, sBP — systolic blood pressure, dBP — diastolic blood pressure, BMI — body mass index, DM — diabetes mellitus, IHD — ischaemic heart disease

Multivariate analysis

In the logistic regression analysis, age, body mass, dyslipidaemia, and HH were selected as significant factors that contribute independently to OH. The odds ratios (per unit increase) were 1.045, 1.031, 2.912, and 4.354, respectively ($P < 0.05$).

DISCUSSION

The patients with OH relating to the increase in sBP before anaesthesia induction were older, had greater BMI, and higher proportions of males, dyslipidaemic subjects, and non-smokers than were ON patients. The patients with HN/OH were older and had higher proportions of males and dyslipidaemic subjects than were the patient with HN/ON. In the logistic regression analysis, age, body mass, dyslipidaemia, and HH were selected as significant factors that contribute independently to OH.

Prevalence

It is reported that WCH is present in from 6.6% to 33.9% [11–15] of patients. OH is present in 10% of patients in another study [2]. Therefore, the prevalence of PAH may be as same as that of WCH.

Ageing alteration

WCH is commonly seen in the elderly, and the prevalence of WCH increases with ageing [16]. It is reported that the ambulatory white coat effect, also called the white coat phenomenon, is higher in people over 65 years old [11]. The prevalence of WCH increases with age from the third (23.2%) to the sixth decade (44.5%), reaches a peak in the sixth decade, and decreases from the sixth to the eighth decade (25.2%) [14]. The left ventricular mass and left ventricular hypertrophy in the elders in WCH are closer to those of the elderly in SH, and are significantly larger than those of elderly normotensive subjects [13]. The ΔsBP values increased significantly with ageing in the previous study [1]. In our present study, the OH and HN/OH groups were significantly older than the ON and HN/ON groups, respectively. In the logistic regression analysis, age was selected as a significant factor that contributes independently to OH. Clinical evaluation of PAH should be conducted with the potential for target organ damage. We should examine the structure and function with ageing in the cardiac and vascular system using echocardiographic analysis in patients with PAH.

TABLE 2. Characteristics of the ON and OH groups

Parameter	ON (n = 119)	OH (n = 112)
sBP in hospital room (mm Hg)	113.1 ± 12.4	125.4 ± 13.1**
sBP in operating room (mm Hg)	117.8 ± 14.0	163.3 ± 18.4**
dBP in hospital room (mm Hg)	67.3 ± 9.8	72.1 ± 12.8**
dBP in operating room (mm Hg)	71.4 ± 12.6	89.9 ± 16.4**
Heart rate in hospital room (beats per min)	75.8 ± 10.8 (n = 115)	73.9 ± 10.6 (n = 107)
Heart rate in operating room (beats per min)	76.6 ± 15.4 (n = 118)	79.9 ± 13.0 (n = 107)
Age (years)	43.8 ± 14.7	57.4 ± 15.2**
Male/Female (n/n)	45/74	57/55*
Height (cm)	162.3 ± 8.7 (n = 118)	161.3 ± 9.4 (n = 109)
Body mass (kg)	58.3 ± 12.6	60.7 ± 12.4 (n = 108)
BMI (kg m^{-2})	22.1 ± 3.9 (n = 118)	23.3 ± 3.7* (n = 108)
DM/Non-DM (n/n)	9/110	9/103
Dyslipidaemia/Non-dyslipidaemia (n/n)	1/118	12/100**
Past history of IHD/Non-IHD (n/n)	1/118	2/109
Smoker/Non-smoker (n/n)	48/61 (n = 109)	32/74* (n = 106)
Drinker/Non-drinker (n/n)	50/58 (n = 108)	47/57 (n = 104)

Data given as mean ± SD or numbers. *$P < 0.05$, **$P < 0.01$ vs. ON group

ON – operating-room normotension, OH – operating-room hypertension, sBP – systolic blood pressure, dBP – diastolic blood pressure, BMI – body mass index, DM – diabetes mellitus, IHD – ischaemic heart disease

Gender difference

WCH is more often found in females than in males. It is reported that in subjects with WCH, female sex is an independent predictor of WCH [17]. In another study, the diagnosis of WCH is independently associated with female sex [18], and multivariate logistic regression in another study shows that female sex is the sole independent predictor of WCH [12]. The prevalence of the white coat effect is greater in females (30% vs. 20%) [19]. Of patients with white coat effect, 74% are females and 26% are males [19].

However, in the previous study the sex ratio in OH was as same as in ON, and the ΔsBP values in males were the same as in females [1]. In the present study, the proportion of males in the OH and HN/OH groups were significantly higher than in the ON and HN/ON groups, respectively. Therefore, the sex ratio in PAH might be different from that in WCH.

Normotensive males typically exhibit higher BP than age-matched premenopausal females [16]. Females are less likely to have hypertension under the influence of oestrogen. Epidemiological evidence suggests a regulatory role for oestrogen in maintaining vascular function and structure [20]. Females have received anti-atherogenic effects of oestrogen, and BP values in females are low compared to males [21]. Loss of ovarian function results in oestrogen deficiency and increased risk for development of cardiovascular diseases, such as hypertension in postmenopausal females and in females with ovarian surgical ablation [20]. Furthermore, plasma renin activity is higher in males than in aged-matched females [22]. Sex steroids can modulate expression and activity of various components of the renin-angiotensin system in kidney and other tissues [23]. These studies have shown that males have higher BP values than do age-matched females, and that there is a significantly greater increase in BP in males than in females.

Body type

The subjects with either WCH or SH have great BMI compared to the normotensive subjects [24]. The ambulatory white coat effect and WCH are higher in obese subjects [11]. The prevalence of obesity increases gradually from the third decade (28.7%) to the fourth (63.6%) and seventh decades (87.0%), and then decreases to the eighth (78.5%) and ninth

TABLE 3. HN/ON, HH/ON, HN/OH, and HH/OH groups

Parameter	HN/ON (n = 116)	HH/ON (n = 3)	HN/OH (n = 95)	HH/OH (n = 17)
sBP in hospital room (mm Hg)	112.4 ± 11.6	142.0 ± 3.5**	121.5 ± 9.3**†	147.3 ± 9.0**‡‡
sBP in operating room (mm Hg)	117.4 ± 14.0	131.7 ± 5.8	162.7 ± 18.4**†	165.9 ± 19.0**†
dBP in hospital room (mm Hg)	66.9 ± 9.5	83.3 ± 5.8	70.3 ± 11.5	82.5 ± 14.7**‡‡
dBP in operating room (mm Hg)	70.9 ± 12.2	90.3 ± 15.0	88.2 ± 16.0**	92.2 ± 18.5**
Heart rate in hospital room (beats per min)	75.6 ± 10.5 (n = 112)	84.7 ± 20.2	73.3 ± 9.0 (n = 91)	77.6 ± 17.2 (n = 16)
Heart rate in operating room (beats per min)	76.9 ± 15.4 (n = 115)	65.0 ± 8.7	79.7 ± 13.2 (n = 91)	80.9 ± 11.9 (n = 16)
Age (years)	43.5 ± 14.8	52.7 ± 9.5	57.1 ± 15.3**	58.5 ± 15.3**
Male/Female (*n/n*)	42/74	3/0*	49/46*	8/9
Height (cm)	162.2 ± 8.7 (n = 115)	170.0± 2.6	161.5 ± 9.3 (n = 92)	160.0 ± 10.2
Body mass (kg)	57.5 ± 11.6	87.0 ± 19.1**	60.1 ± 12.2†† (n = 93)	63.9 ± 13.3†
BMI (kg m^{-2})	21.9 ± 3.6 (n = 115)	30.2 ± 7.7**	23.0 ± 3.5† (n = 92)	24.6 ± 4.1*
DM/Non-DM (*n/n*)	8/108	1/2	9/86	0/17
Dyslipidaemia/Non-dyslipidaemia (*n/n*)	1/115	0/3	8/87**	4/13**
Past history of IHD/Non-IHD (*n/n*)	0/116	1/2**	2/93††	0/17†
Smoker/Non-smoker (*n/n*)	47/59 (n = 106)	1/2	26/65 (n = 91)	6/9 (n = 15)
Drinker/Non-drinker (*n/n*)	49/56 (n = 105)	1/2	39/50 (n = 89)	8/7 (n = 15)

Data given as mean ± SD or numbers. *$P < 0.05$, **$P < 0.01$ vs. HN/ON group; †$P < 0.05$, ††$P < 0.01$ vs. HH/ON group; ‡$P < 0.05$, ‡‡ $P < 0.01$ vs. HN/OH group

HN/ON – hospital-room normotension and operating-room normotension, HH/ON – hospital-room hypertension and operating-room normotension, HN/OH – hospital-room normotension and operating-room hypertension, HH/OH – hospital-room hypertension and operating-room hypertension, sBP – systolic blood pressure, dBP – diastolic blood pressure, BMI – body mass index, DM – diabetes mellitus, IHD – ischaemic heart disease

decades (60.0%) of life, a pattern which is similar to that of WCH [14]. In the present study, the patients in the HH/OH group had greater BMI than those in the HN/ON group. In the logistic regression analysis, body mass was selected as a significant factor that contributes independently to OH.

There is a gradual increase in the prevalence of WCH in addition to the gradual decrease in the prevalence of sustained normotensive subjects from underweight towards normal weight and overweight [25]. The detected higher prevalence of PAH, even in early decades, despite the lower prevalence of excess weight in this age range, may indicate a trend towards weight gain and many consequent diseases.

Due to the gradually increased prevalence of WCH from underweight towards normal weight and overweight [25], parallel to the already known increasing prevalence of SH, DM, hyperbetalipoproteinaemia, dyslipidaemia, and coronary heart disease, PAH might also preferentially be accepted as an alarming sign of excess weight and many associated disorders in the future, rather than just being considered a predisposing factor of SH or atherosclerosis.

Dyslipidaemia

In the present study, the patients in the OH and HN/OH groups had dyslipidaemia more than those in the ON and HN/ON groups, respectively. In the logistic regression analysis, dyslipidaemia was selected as a significant factor that contributes independently to OH. The prevalence of hyperbetalipoproteinaemia, hypertriglyceridaemia, and dyslipidaemia increase significantly until the seventh decade and then decrease significantly – a pattern which is similar to that for WCH [14]. The prevalence of dyslipidaemia is high in WCH (41.6%) compared to sustained normotension (19.6%) and SH (35.5%) [15].

On the basis of standardised duplex ultrasound examination of the carotid arteries, maximal intimal-medial thickness [24, 26], plaque index [24], and cross-sectional area [26] in the subjects with WCH are greater than in the normotensive subjects and equal to those of the subjects with SH. Because WCH with metabolic syndrome shows higher left ventricular mass index and longer E-wave deceleration time by echocardiographic examination, metabolic syndrome may have a deleterious influence on left ventricular structure and function in WCH [27]. These findings suggest that PAH contributes to the presence of arteriosclerosis in a manner similar to WCH.

Hypertension and hypercholesterolaemia are characterised by similar proatherogenic hallmarks, including endothelial dysfunction, vascular inflammation, and oxidative stress [28]. Experimental analysis of the interaction between hypertension and hyperlipidaemia on the mechanism of early atherosclerosis indicates that hypertension induces adaptive remodelling, whereas for the maladaptive intima-media thickening, hyperlipidaemia might be necessary [29].

Non-smoking

The ambulatory and self-measured white coat effect is higher in non-smokers [11], and WCH is frequent in non-smokers [12], although smoking is an independent predictor of subsequent cardiovascular events [30]. Because smokers often report that cigarettes help relieve feelings of stress, smoking may reduce the emotional discomfort of stress. Actually, smoking dampens plasma cortisol responses to stress tests [31], and nicotine self-administration diminishes mild foot shock stress-induced norepinephrine secretion in the hypothalamic paraventricular nucleus [32]. In the present study, the patients in the OH group included a higher rate of non-smokers than in the ON group. Therefore, we speculate that patients with smoking habits are less consistently shown in PAH. However, there were no differences among the four groups.

Outcome

The prevalence of SH, DM, and IHD always increase with age and do not decrease, indicating that the increases are irreversible as opposed to the reversible patterns of excess weight, hyperbetalipoproteinaemia, hypertriglyceridaemia, dyslipidaemia, and WCH [14]. The prevalence of nearly all of the health problems, including obesity, DM, and IHD, might show significant progression from sustained normotension towards WCH and SH, with WCH being found as an intermediate step. Patients with concomitant IHD already have atherosclerosis and endothelial injury. Patients with myocardial ischaemia already have large afterload and myocardial hypertrophy [33]. Therefore, PAH may also be considered in a pre-hypertensive state.

WCH carries a significantly better prognosis than SH [34], and WCH confers lower risk of death than does SH [35]. However, it has been reported in the Ohasama study that WCH is a risk factor for development of home hypertension [36]. 46.9% of subjects with WCH progressed to home hypertension in an eight-year follow-up study [37], and the results demonstrated that WCH is a transitional condition eventually terminating with home hypertension. Then the presence of WCH is an independent predictor of subsequent cardiovascular events [30]. It is reported that the incidence of adverse outcomes, elevated troponin, or in-hospital mortality is 1.3% for PAH overall and 2.8% for the subset of PAH patients with baseline sBP greater than 200 mm Hg [2]. The independent predictors of adverse outcome in PAH include increased baseline sBP and increased age [2]. The existence of PAH might increase the risk of cardiac and vascular complications in the perioperative period. Therefore, patients with PAH also may have a worse or equal cardiovascular prognosis than the normotensive subjects but a better one than those with SH. Patients with uncomplicated PAH should probably not receive medical therapy, but rather a close follow-up, including regular assessment of other risk factors.

Organ and function

The structure and function of heart and vessels in WCH may locate between normotension and SH. The left ventricular mass by echocardiographic analysis is large in WCH compared to that seen in the normotensive subjects [13, 38], and the prevalence of left ventricular hypertrophy is great in WCH [13]. Left ventricular diastolic function is much impaired in WCH compared to those in the normotensive subjects, and aortic elastic properties are slightly impaired in WCH [39]. Furthermore, plasma homocysteine, which promotes oxidant injury to the vascular endothelium, impairs endothelium-dependent vasomotor regulation and may also alter the coagulation properties of the blood; levels in the subjects with WCH are higher than in normotension and lower than in SH [38]. WCH is associated with endothelial dysfunction and abnormal angiogenesis, and the degree of these changes is not as severe as that observed in SH by evaluating nitric oxide, endothelin-1, vascular endothelial growth factor, and E-selectin levels in plasma [40]. We should also examine the organ and function in the cardiac and vascular system in patients with PAH.

Limitations

This was a cross-sectional observational study. In the absence of prior home or ambulatory recorded BP data before admission to the hospital, it seemed likely that some of the patients in the HH/OH group may have suffered from un-diagnosed and un-treated hypertension. In the present study, the 231 persons used for analyses may also include un-diagnosed or un-treated hypertension. The data of the BP in the hospital room and operating room were measured on different arms of patients only once with different sizes of cuffs by different medical staff. It is known that the increase in sBP during measurement by the nurse is less than during measurement by the doctor [10]. Because automatic BP measurement may be inaccurate, we should investigate with mercury sphygmomanometers to obtain more accurate BP data. We should measure, multiple times, home or 24-hour ambulatory sBP [41] to obtain proper data and exclude the subjects with un-diagnosed or un-treated hypertension, and we should chronologically measure sBP on the same arms of patients with the same BP measurement devices before and after entering the operating room.

The present analysis was limited by its retrospective design. The data were retrospectively collected on consecutive operations and extracted from hospital records and anaesthesia records. In the absence of a clear study protocol, the data had been collected as part of routine management. This study includes emergency surgery during day or night. The serum hormonal and catecholamine level in the patients for emergency surgery might be different from usual. Their haemodynamics between day and night would be different [7], and circadian variation should be considered. In addition, the cardiovascular changes associated with pregnancy may behave differently to other patients. Longer duration of NPO for elective surgery may induce dehydration in elderly subjects, and dehydration may be associated with PAH. Patients did not take any premedication in this study, and no premedication may be a risk for patients with IHD. We would investigate elective surgeries during the daytime, excluding the emergency and obstetric surgeries in the prospective study.

Ageing, obese subjects, dyslipidaemic subjects, and hypertensive subjects in the hospital room might be limited risk factors, all of which affect ΔsBP, but not only these four risk factors. We speculate that some other risk factors affect the difference in PAH. Therefore, we need to investigate the influence of medication and coexisting disease before anaesthesia and surgery, and in detail the association between PAH and cardiac and vascular risk in the peri-operative period.

We speculate that the medical environment of the operating room and anxiety and medical stress about the anaesthesia and surgery may influence BP more greatly than that of the outpatient clinic and hospital ward. Therefore, we need to investigate and compare anxiety or stress test for patients with WCH and PAH.

CONCLUSIONS

The clinical characteristics of the patients with OH are: elders, obese subjects, dyslipidaemic subjects, and hospital-room hypertensive subjects. Ageing, obesity, dyslipidaemia, and hospital-room hypertension are clinical risk factors relating to PAH. These results might add information that can guide the clinical management or risk stratification of patients with PAH.

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