

BLOOD PRESSURE CHANGES ON DEVELOPMENT AND REGRESSION
OF ELECTROCARDIOGRAPHIC LEFT VENTRICULAR HYPERTROPHY:
A 26-YEAR LONGITUDINAL STUDY

心電図左室肥大の進展・退縮と血圧の関係についての検討
26年間に及ぶ長期追跡調査

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SUMMARY

At RERF, medical examinations have been conducted biennially since 1958 on a fixed population of approximately 20,000 individuals. The measurement of blood pressure and recording of electrocardiogram (ECG) are both available for 6,569 individuals who were monitored for at least 11 of the 13 two-year intervals between 1958-84. Six hundred and one individuals, who had satisfied the RERF diagnostic criteria for left ventricular hypertrophy (LVH) based on ECG (Kagan-Yano Code) on at least one occasion, were reviewed. Both the development and regression of ECG-detected LVH (ECG-LVH) were ascertained in 61 subjects (17 males and 44 females). During the course of ECG-LVH development, hypertension (including borderline cases) was noted in 83.3% of the subjects. The most common ECG pattern of LVH development was the occurrence of high-voltage followed by ST-T change. In about one-half of the ECG-LVH cases, the condition of regression was associated with the lowering of blood pressure, marked by the disappearance of high-voltage ECG readings.

要 約

放影研では、約20,000人の固定集団について1958年以來、2年ごとに検診を行っている。1958-84年の13周期のうち、11周期以上で血圧測定及び心電図記録の施行されたのは6,569人であった。放影研における心電図上の左室肥大診断基準(Kagan-Yano Code)を1回でも満たした601人について検討を行った。同一症例において、心電図左室肥大の進展及び退縮を共に認めたのは61人(男17, 女44)であった。心電図左室肥大の進展の認められた周期における高血圧(境界域高血圧を含む)の割合は、83.3%であった。心電図左室肥大の最も多い進展様式は、高電位差に引き続いてST-T変化の出現する型であった。一方、心電図左室肥大の退縮に血圧の低下が関与しているのは約半数であり、高電位差の消失が最も多い退縮の型であった。

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放影研顧問

INTRODUCTION

The relationship between hypertension and the development of LVH has been studied extensively, and it is well known that hypertension is often accompanied by LVH.¹⁻³ An epidemiologic study in Framingham district indicated that LVH, accompanied by high-voltage and ST-T changes, was observed in one-half of the cases with the systolic blood pressure of 180 mmHg or more.³ It has also been noted that LVH development, particularly in elderly persons, is closely related to the presence of hypertension, and that the frequency of LVH is higher among young or borderline hypertensives than among individuals with normal blood pressure.^{4,5} Although ECG-LVH has been reported more frequently among Japanese males living in Japan than among those Japanese in Hawaii and California, elevated blood pressure was not correlated to the presence of LVH in an earlier RERF study.⁶ In that cross-sectional analysis of the relationship between blood pressure and LVH, only a short period of time was considered. A search of the literature did not reveal any report dealing with the longitudinal relationship between blood pressure and the development and regression of LVH. Several studies using ECG have demonstrated that the regression of LVH correlated with successful control of hypertension, but the period of follow-up was relatively short (1-9 years).⁷⁻⁹ At RERF, medical examinations including the measurement of blood pressure and ECG recordings have been conducted biennially since 1958 on an initially fixed population of approximately 20,000 individuals.¹⁰ This population, therefore, is considered most appropriate to study the relationship between the longitudinal changes of blood pressure and the development and regression of LVH.

MATERIALS AND METHODS

Our study uses data from the initially fixed population of about 20,000 individuals who were the basis of the RERF Adult Health Study (AHS) sample.¹⁰ Members of this population have been examined once every two years since 1958, and we will refer to the 2-year intervals between examinations as "cycles" (i.e., cycle 1: July 1958 - June 1960, cycle 2: July 1960 - June 1962, ..., cycle 13: July 1982 - June 1984). With participation rates in the study varying from 75% to 85% and some natural decrease of participants occurring during the 26-year period, both blood pressure and ECG data were

緒言

高血圧と左室肥大の進展に関する研究は古くからなされており、高血圧で左室肥大の合併が多いことはよく知られている。^{1,3} Framingham 地区における疫学的な調査によると、収縮期血圧が 180mmHg 以上の例ではその半数に高電位差と ST-T 変化を伴った左室肥大の所見が認められている。³ 特に高齢者の左室肥大には、高血圧の関与が強いとされているが、若年者や境界域の高血圧患者においても、左室肥大の頻度は正常血圧者に比べて多いとの報告^{4,5}がある。一方、放影研における以前の研究⁶では、日本在住の日本人男子では、心電図左室肥大の発生率が Hawaii, California 居住者に比較して高いとされているが、その左室肥大の出現と血圧値との関係は少ないと報告されている。しかし、これらの血圧値と左室肥大の関係の分析は、時間経過を考慮していない一断面における分析である。血圧と左室肥大の進展・退縮の長期的な関係を検討した報告は見当たらない。左室肥大の退縮が、高血圧のコントロールと関係していることを、心電図を使って検討した報告は幾つかあるが、追跡期間が比較的短い(1~9年)。⁷⁻⁹ 放影研では血圧の測定と心電図記録を含む検診を、当初約20,000人の固定集団について1958年以来2年ごとに行っている。¹⁰ したがって、この集団は血圧の経時的変化と、左室肥大の進展及び退縮の関係を検討するのに最も適した集団と考えられる。

対象及び方法

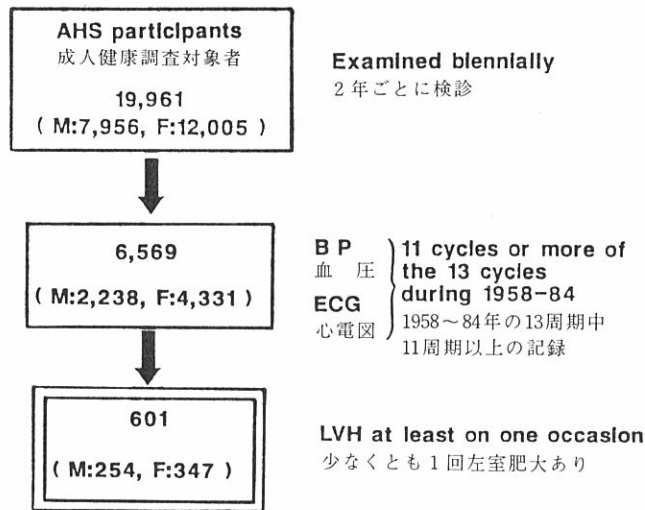
この研究の対象は、放影研の成人健康調査(AHS)を形成する、当初約20,000人の固定集団である。¹⁰ この集団の者は、1958年以来2年ごとに各周期(すなわち第1周期: 1958年7月-1960年6月, 第2周期: 1960年7月-1962年6月, ..., 第13周期: 1982年7月-1984年6月)に1回検診を受けている。本調査の受診率は75%~85%であり、26年間に受診の自然消失があるため、1958-84年の13周期中11周期以上で血圧測定と心電図記録が共に実施できたのは6,569人(男2,238,

available for only 6,569 individuals (2,238 males and 4,331 females) for 11 or more of the 13 cycles between July 1958 and June 1984. We chose to study 601 individuals (254 males and 347 females) who had satisfied on at least one occasion the RERF diagnostic criteria for LVH based on ECG (Kagan-Yano Code)⁶ as shown in Table 1.¹¹

女 4,331)であった。このうち放影研における心電図左室肥大の診断基準 (Kagan-Yano Code) を 1 回でも満たした表 1 に示す 601 人 (男 254, 女 347)¹¹ について検討した。

TABLE 1 STUDY DESIGN

表 1 研究図式



Blood Pressure Measurements

Blood pressure was determined by means of a mercury sphygmomanometer while the individual was seated with one's left arm at the level of the heart. The systolic and diastolic blood pressures were defined as the blood pressure at the point of onset and cessation of Korotkoff's sounds, i.e., at Swan's first and fifth points.

Electrocardiogram Recordings

Standard 12-lead ECG was recorded at a paper speed of 25 mm/sec.

Diagnostic Criteria

World Health Organization criteria (1978) were used to classify hypertension as follows:

Normotension: systolic ≤ 140 and diastolic ≤ 90 mmHg

血圧測定

血圧は水銀血圧計を用いて、坐位で各対象者の左腕を心臓と同じ高さにして測定した。収縮期血圧及び拡張期血圧は、コロトコフ音の開始及び消失点、すなわちスワンの第1及び第5点における血圧と定義した。

心電図記録

標準12誘導心電図を25mm/秒のペーパースピードで記録した。

診断基準

高血圧の分類には下記のWHO診断基準(1978年)を用いた。

正常血圧: 収縮期血圧 140mmHg 以下かつ拡張期血圧 90mmHg 以下。

Borderline: systolic 141 to 159 and/or diastolic 91 to 94 mmHg

Hypertension: systolic ≥ 160 and/or diastolic ≥ 95 mmHg

LVH was defined solely on the basis of ECG, and the condition was diagnosed in the presence of high-voltage QRS complex and ST-T wave abnormalities (Kagan-Yano Code).⁶ Subjects with valvular heart disease evident upon physical examination and those exhibiting complete and incomplete left bundle branch block on ECG were excluded from the study.

RESULTS

During the 26 years (13 cycles) of follow-up, both the development and regression of ECG-LVH were observed in 61 (17 males and 44 females) of the 601 individuals (254 males and 347 females) who satisfied the criteria for ECG-LVH on at least one occasion. The mean ages (\pm standard error of the mean) during development and regression of ECG-LVH were 57.0 ± 1.3 and 61.2 ± 1.3 (58.4 ± 3.0 and 63.7 ± 2.5 in males, 56.4 ± 1.5 and 60.2 ± 1.5 in females) as shown in Table 2. Blood pressure measurement was unavailable during the development of ECG-LVH in one subject, so this case was excluded from the subsequent analyses.

境界域: 収縮期血圧 141~159mmHg かつ/又は 拡張期血圧 91~94mmHg.

高血圧: 収縮期血圧 160mmHg 以上かつ/又は 拡張期血圧 95mmHg 以上.

左室肥大は心電図によってのみ定義し, QRS 高電位差と ST-T 異常 (Kagan-Yano Code) によって診断した.⁶ 現症で明らかな弁膜症の患者, 心電図上, 完全及び不完全左脚ブロックの者は除外した.

結 果

26年間(13周期)の追跡期間中, 心電図左室肥大の進展及び退縮が共に認められたのは, 心電図左室肥大の基準を少なくとも1回満たした601人(男254, 女347)のうち, 61人(男17, 女44)であった. 心電図左室肥大の進展及び退縮の周期における平均年齢(平均 \pm 標準誤差)は, 表2のようにそれぞれ 57.0 ± 1.3 歳, 61.2 ± 1.3 歳(男 58.4 ± 3.0 歳, 63.7 ± 2.5 歳, 女 56.4 ± 1.5 歳, 60.2 ± 1.5 歳)であった. 心電図左室肥大の進展周期において血圧測定が得られないのが1例あり, この例は以下の検討から除外した.

TABLE 2 AGE AT THE TIME OF DEVELOPMENT AND REGRESSION OF ECG-LVH

表2 心電図左室肥大の進展・退縮周期時の年齢

Sex	Cases	Mean age \pm standard error in years	
		Development	Regression
Male	17	58.4 ± 3.0	63.7 ± 2.5
Female	44	56.4 ± 1.5	60.2 ± 1.5
Total	61*	57.0 ± 1.3	61.2 ± 1.3

*Eleven subjects who had ECG-LVH at their first examination were excluded.

初回の検診で既に心電図左室肥大のあった11名を除く.

Development of ECG-LVH

The frequency of hypertension during the course of development of ECG-LVH, i.e., as shown by the presence of high-voltage QRS complex and ST-T wave changes, was 65.0% (39/60) in total,

心電図左室肥大の進展

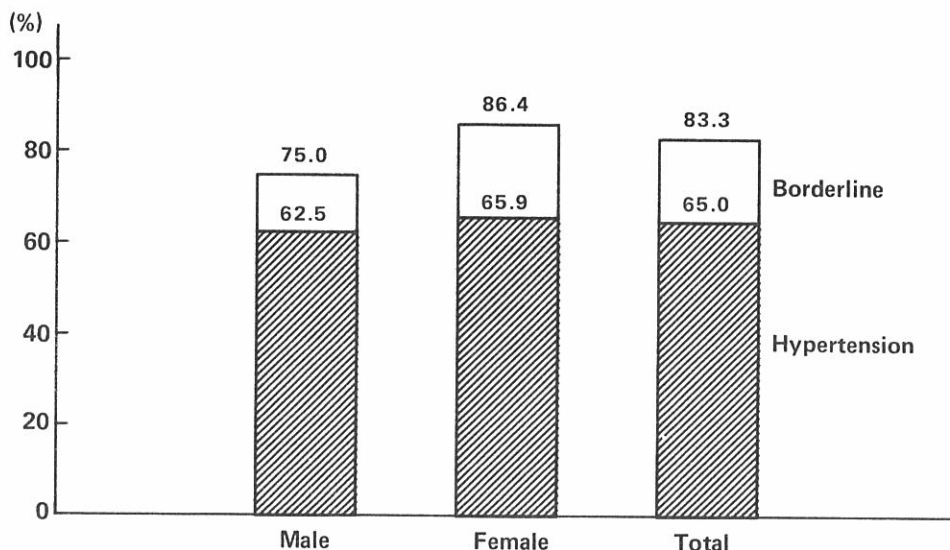
心電図左室肥大の進展, すなわち QRS 高電位差及び ST-T 変化が共に認められた周期における高血圧の頻度は, 男女合計で65.0% (39/60), 男 62.5%

62.5% (10/16) in males, and 65.9% (29/44) in females. The frequency rose to 83.3% (50/60) overall when borderline hypertension was included: 75.0% (12/16) in males and 86.4% (38/44) in females (Figure 1).

(10/16), 女 65.9% (29/44) であった。境界域高血圧まで含めるとその頻度はそれぞれ、男女合計83.3% (50/60), 男 75.0% (12/16), 女 86.4% (38/44) に上昇した(図1)。

FIGURE 1 FREQUENCY OF HYPERTENSION IN THE COURSE OF DEVELOPMENT OF ECG-LVH BY SEX

図1 心電図左室肥大の進展周期における高血圧の頻度、性別



The following patterns of ECG-LVH development were observed: 1) high-voltage followed by ST-T changes (37/60), 2) ST-T changes followed by high-voltage (10/60), and 3) simultaneous high-voltage and ST-T changes (13/60). Thus, the most common pattern was high-voltage followed by ST-T changes.

The frequency of hypertension for these different patterns of ECG-LVH development was 67.6% (25/37), 50.0% (5/10), and 69.2% (9/13), respectively. These values increased to 91.9% (34/37), 60.0% (6/10), and 76.9% (10/13), when borderline hypertension was included (Table 3).

Regression of ECG-LVH

The regression of ECG-LVH was studied in 72 individuals. These included 61 subjects who developed ECG-LVH during the follow-up period and 11 subjects who already had ECG-LVH at their first examination. The regression of ECG-LVH was associated with disappearances of high-voltage (36/72), ST-T changes (25/72), or both high-voltage and ST-T changes (11/72) as shown in Table 4.

次の心電図左室肥大の進展の型が認められた。1) 高電位差に続いて ST-T 変化が出現 (37/60), 2) ST-T 変化に続いて高電位差が出現 (10/60), 及び 3) 高電位差及び ST-T 変化が同時に出現 (13/60)。すなわち、最も多い型は、高電位差に続いて ST-T 変化が出現する型であった。

これらの異なった心電図左室肥大の進展の型における高血圧の頻度は、それぞれ67.6% (25/37), 50.0% (5/10), 69.2% (9/13) であった。これらの値は、境界域高血圧まで含めるとそれぞれ、91.9% (34/37), 60.0% (6/10), 76.9% (10/13) に上昇した(表3)。

心電図左室肥大の退縮

心電図左室肥大の退縮は、72例について検討した。これらには、追跡期間中に心電図左室肥大が進展した61例と、初回受診時に既に心電図左室肥大の認められた11例が含まれていた。心電図左室肥大の退縮は表4に示すように、高電位差の消失(36/72), ST-T 変化の消失(25/72), 高電位差と ST-T 変化が同時に消失(11/72)であった。

TABLE 3 PATTERN OF ECG-LVH DEVELOPMENT AND HYPERTENSION

表3 心電図左室肥大の進展様式と高血圧

ECG pattern	Cases	Hypertension (%)	Including borderline hypertension (%)
High-volt. → ST-T changes	37	25 (67.6)	34 (91.9)
ST-T changes → High-volt.	10	5 (50.0)	6 (60.0)
Both high volt. and ST-T changes simultaneously	13	9 (69.2)	10 (76.9)
Total	60*	39 (65.0)	50 (83.3)

*One cases for whom blood pressure measurement was unavailable during the development of ECG-LVH was excluded.

心電図左室肥大の進展期間に血圧測定がなかった1名を除く。

TABLE 4 ECG-LVH REGRESSION

表4 心電図左室肥大の退縮

ECG reading	Male	Female	Total
High-voltage	12	24	36
ST-T changes	8	17	25
Both high volt. and ST-T changes simultaneously	2	9	11
Total	22	50	72*

*These included 61 subjects who developed ECG-LVH during the follow-up period and 11 subjects who had ECG-LVH at their first examination.

追跡期間中心電図左室肥大の進展した61名と、初回検診時に心電図左室肥大のあった11名を含む。

It was noted that the regression of ST-T changes (Table 5) was characterized by the following: 1) The age of subjects in the regression cycle was younger than that for voltage regression (56.9 ± 2.4 vs 62.1 ± 1.6), and 2) the systolic blood pressure noted in the course of regression was higher than that during voltage regression (160.2 ± 6.1 vs 152.9 ± 3.2).

Temporal changes in blood pressure were assessed in five consecutive examination cycles and LVH regression occurred midway as shown in Figure 2. Blood pressure readings for five consecutive cycles were available in 45 cases, which indicated that systolic and diastolic blood pressures declined during the course of the LVH regression. This tendency was observed in all types of ECG-LVH regression.

ST-T 変化の退縮は、次の点で特徴づけられた (表5)。1) 退縮の周期における年齢が、高電位差の退縮期の年齢に比べて若かった (56.9 ± 2.4 対 62.1 ± 1.6)、及び 2) 退縮の周期における収縮期血圧が、高電位差の退縮期の収縮期血圧に比べて高かった (160.2 ± 6.1 mmHg 対 152.9 ± 3.2 mmHg)。

図2に示すように、血圧の経時的変化を、左室肥大の退縮周期を中央に、連続する5周期において評価した。45例において連続する5周期の血圧値が得られ、収縮期及び拡張期血圧ともに、左室肥大の退縮周期において低下した。この傾向は、すべての型の心電図左室肥大の退縮で認められた。

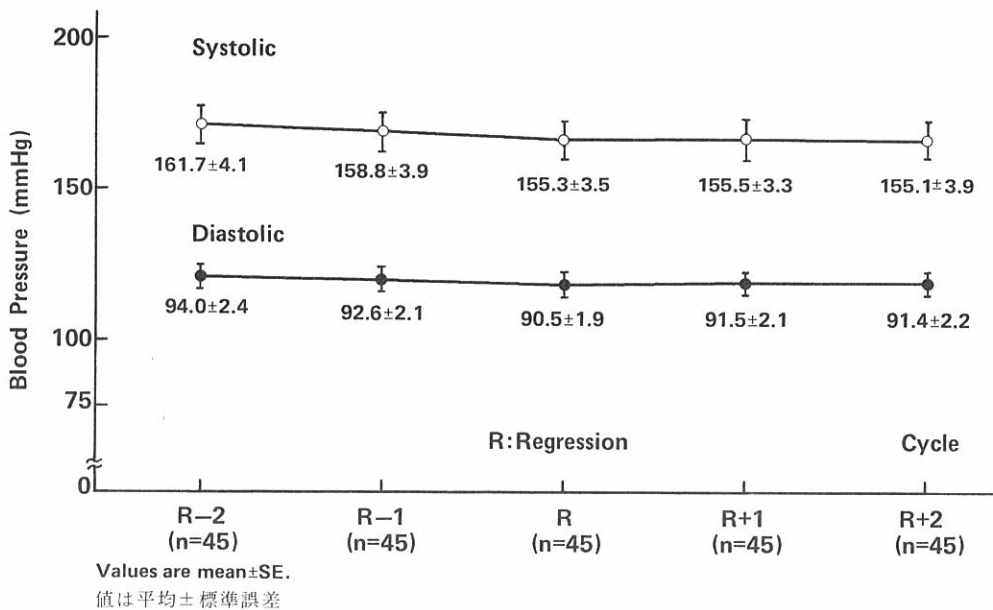
TABLE 5 AGE AND BLOOD PRESSURE DURING ECG-LVH REGRESSION

表 5 心電図左室肥大の退縮周期における年齢と血圧

ECG reading	Cases	Mean \pm standard error		
		Age (yr)	SBP (mmHg)	DBP (mmHg)
High-voltage	36	62.1 \pm 1.6	152.9 \pm 3.2	88.3 \pm 1.7
ST-T changes	25	56.9 \pm 2.4	160.2 \pm 6.1	91.1 \pm 2.8
Both high volt. and ST-T changes simultaneously	11	62.2 \pm 3.4	150.9 \pm 9.4	88.0 \pm 4.7
Total	72	60.3 \pm 1.3	155.1 \pm 3.0	89.2 \pm 1.5

FIGURE 2 CHANGES IN BLOOD PRESSURE OVER THE COURSE OF TIME: FIVE CONSECUTIVE CYCLES WITH LVH REGRESSION OCCURRING AT THE MIDPOINT OF THIS 10-YEAR TIME PERIOD

図 2 血圧変化の経過：左室肥大退縮周期を中央に連続5周期(10年)について



To investigate the individual relationship between ECG-LVH regression and the lowering of blood pressure, the following criterion for blood pressure index (BPI) was used.

心電図左室肥大の退縮と血圧の低下の関係を個々の例において検討するために、次のような基準(血圧指数)を用いた。

$$BPI = \frac{BP(R) - BP(R - 1)}{BP(R - 1)} \times 100\% ,$$

where BP(R) is blood pressure during the course of LVH regression, and BP(R - 1) is blood pressure just before LVH regression. BPI can be calculated for both the systolic and diastolic blood pressures. If the BPI was less than or equal to -5%, ECG-LVH regression was considered to be significantly associated with lowering of either systolic or diastolic blood pressure. Four persons (one male and three females) out of 72 cases were excluded because blood pressure readings for the 2-year cycle preceding LVH regression were not available. As shown in Table 6, 51.5% of the incidences of decreased systolic blood pressure and 41.2% of the incidences of decreased diastolic blood pressure were associated with the ECG-LVH regression.

ただし BP(R) は左室肥大退縮周期の血圧、及び BP(R - 1) は左室肥大退縮の直前周期の血圧。血圧指数は、収縮期血圧及び拡張期血圧について計算される。血圧指数が-5%以下の場合、心電図左室肥大の退縮に収縮期又は拡張期血圧の低下が関与していると判定した。72例中、4例(男1例、女3例)は左室肥大退縮の直前周期の血圧値が得られず除外した。表6に示すように、収縮期血圧の51.5%及び拡張期血圧の41.2%が、その低下が心電図左室肥大の退縮と関連していた。

TABLE 6 FREQUENCY OF BPI LOWERING IN ASSOCIATION WITH REGRESSION OF LVH

表6 左室肥大の退縮に関わる血圧指数の低下の頻度

Sex	Cases	Associated with lowering of blood pressure (%)	
		Systolic	Diastolic
Male	21	13 (61.9)	10 (47.6)
Female	47	22 (46.8)	18 (38.3)
Total	68*	35 (51.5)	28 (41.2)

*Four (one male and three females) out of 72 cases (Tables 4 and 5) were excluded, because blood pressure readings for the 2-year cycle preceding LVH regression were not available.

72名(表4及び5)中4名(男1、女3)は2年ごとの診察周期で血圧測定値が得られなかったので除いた。

The association of decreased blood pressure and the frequency of ECG-LVH regression of varying types are as follows: 52.8% of cases with lowered blood pressure exhibited high-voltage regression, 56.5% regression of ST-T changes, and 33.3% both regression of high-voltage readings and ST-T changes (Figure 3). The relationship between longitudinal changes in ECG and blood pressure are shown for typical cases of high-voltage regression (Figure 4), ST-T changes (Figure 5), and high-voltage and ST-T changes combined (Figure 6).

血圧の低下と関連したそれぞれ異なった型の心電図左室肥大の退縮の頻度は、高電位差の退縮、52.8%、ST-T変化の退縮、56.5%、高電位差及びST-T変化が共に退縮、33.3%であった(図3)。心電図と血圧の関係の長期的経過を三つの典型的な例、すなわち高電位差の退縮(図4)、ST-T変化の退縮(図5)、高電位差及びST-T変化が共に退縮(図6)について示す。

FIGURE 3 EFFECTS OF DECREASED SYSTOLIC BLOOD PRESSURE ON THE THREE TYPES OF ECG-LVH REGRESSION

図3 三つの型の心電図左室肥大退縮に及ぼす収縮期血圧低下の影響

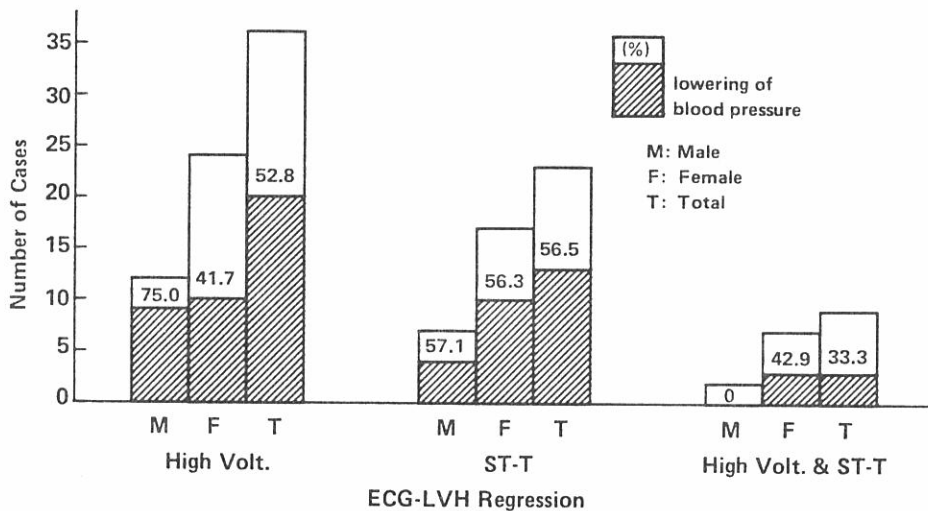
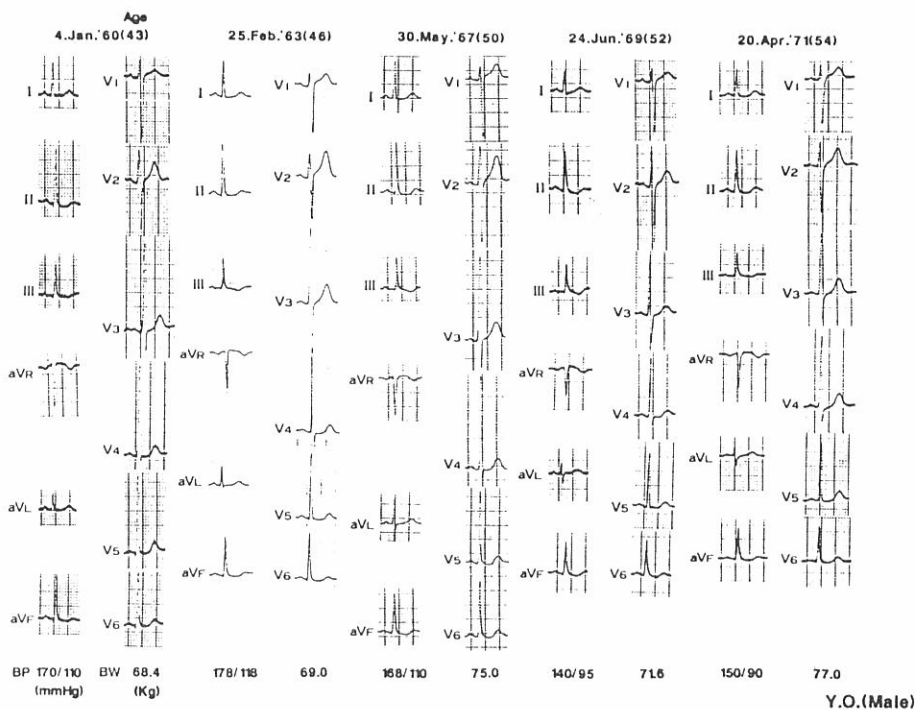


FIGURE 4 CASE 1, HIGH-VOLTAGE REGRESSION

図4 症例1 高電位差の退縮

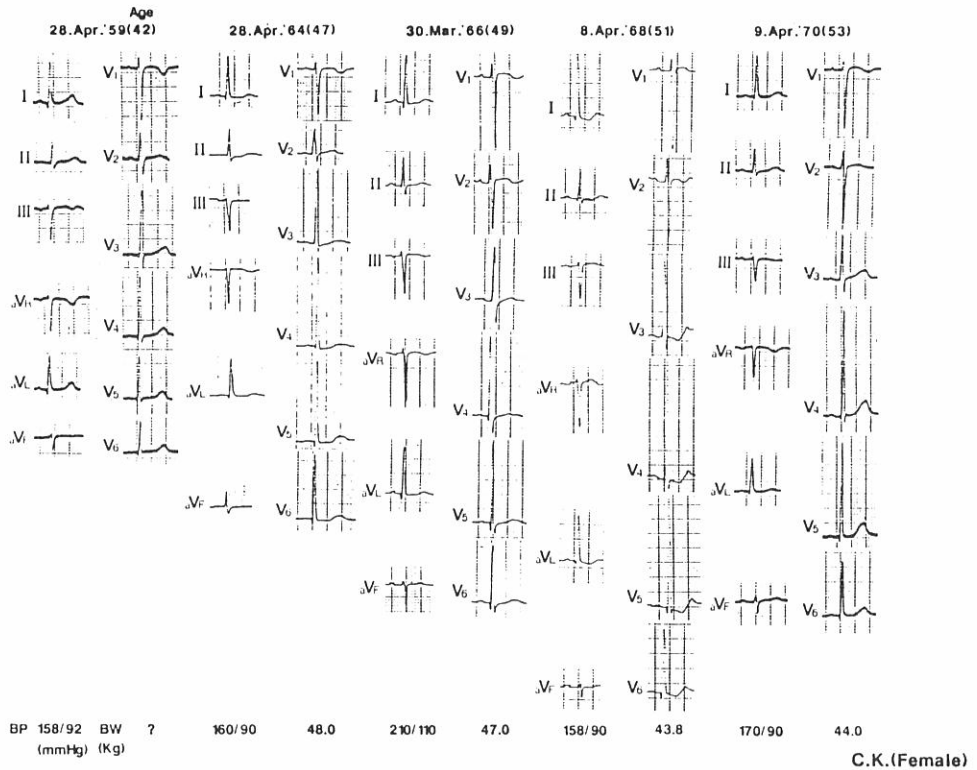


At age 43, high-voltage ($Sv1+Rv5=47mm$) and ST depression in V4-6 had already been observed. At age 50, high-voltage ($Sv1+Rv5=45mm$) and ST depression in V4-6 were persistent. At age 52, high-voltage disappeared ($Sv1+Rv5=34mm$) though ST depression in V4-6 was persistent.

43歳のとき、高電位差 ($Sv1+Rv5=47mm$) 及び V4-6 における ST 低下が既にみられた。50歳のとき、高電位差 ($Sv1+Rv5=45mm$) と V4-6 における ST 低下が継続、52歳のとき、高電位差 ($Sv1+Rv5=34mm$) は消失したが V4-6 の ST 低下はそのまま存続した。

FIGURE 5 CASE 2, ST-T CHANGES REGRESSION

図5 症例2 ST-T 変化の退縮



At age 47, both high-voltage ($Sv1+Rv5=44mm$) and ST depression (junctional in V3-4, horizontal in V5-6) were observed. At age 51, high-voltage increased ($Sv1+Rv5=63mm$) and ST strains were present in V3-6. At age 53, ST-T changes almost disappeared though high-voltage was persistent ($Sv1+Rv5=52mm$).

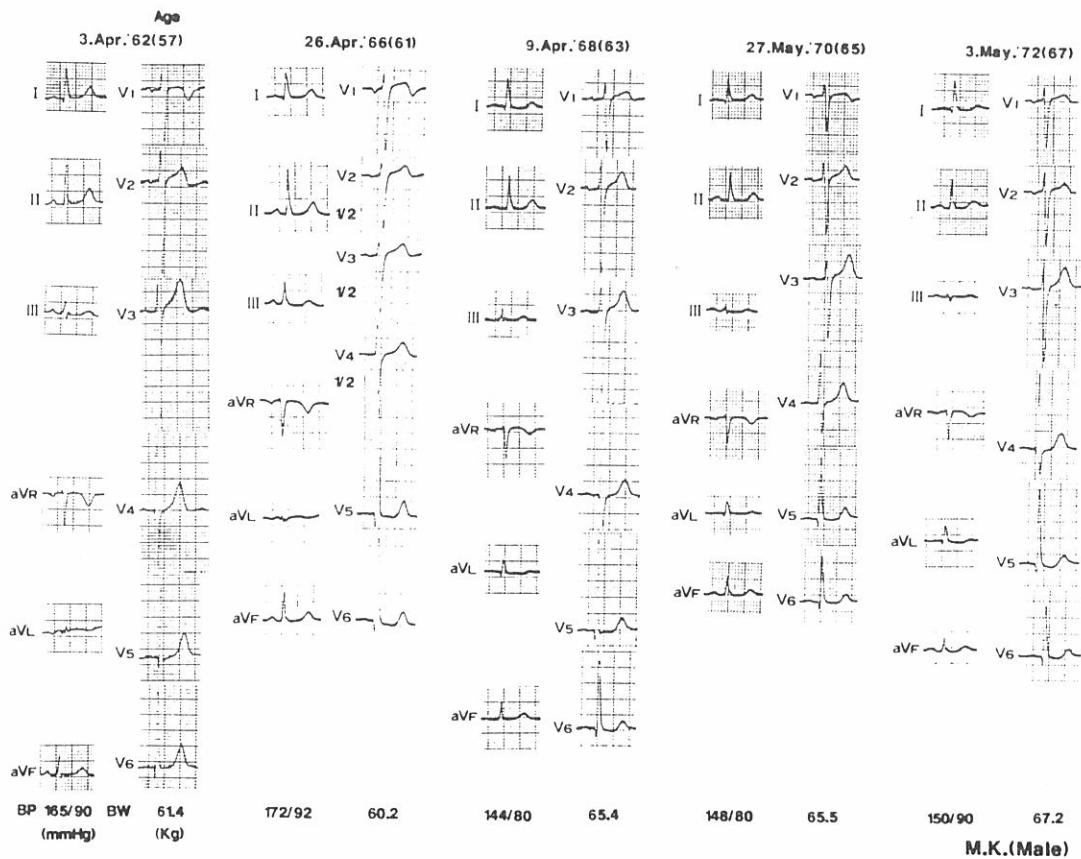
47歳のとき、高電位差 ($Sv1+Rv5=44mm$) 及び V3-6 における ST 低下 (V3-4 では J 型, V5-6 では水平型) が見られ、51歳のとき高電位差が増加 ($Sv1+Rv5=63mm$)、V3-6 では ST ストレインが見られた。53歳で ST-T 変化はほとんど消失したが、高電位差は続いた ($Sv1+Rv5=52mm$)。

To determine whether the regression of ECG-LVH was associated with the lowering of blood pressure, Wilcoxon's rank sum test was performed. As for controls, 129 subjects, of whom ECG-LVH development was first diagnosed during either the 12th or 13th cycle, were used. Five cases (three males and two females) were not age- and sex-matched when the difference in their ages at the time of the bomb (August 1945) was less than or equal to five. As shown in Table 7, the changing rates of both systolic and diastolic blood pressures, with the exception of the diastolic blood pressure in males during the examination cycle just before the ECG-LVH regression and during the cycle when ECG-LVH regression occurred, were statistically significant when compared with the control group.

心電図左室肥大の退縮が血圧の低下と関連しているかどうかを検討するために、Wilcoxon の順位差検定を行った。心電図左室肥大の進展が、第12又は第13周期において初めて出現した129例を対照群とした。5例(男3例、女2例)は、被爆時(1945年8月)の年齢差が5歳以下で性・年齢をマッチさせると当てはまらなかった。表7に示すように、心電図左室肥大の退縮時血圧値の退縮直前周期血圧値に対する変化率(収縮期及び拡張期)は、対照群に比し男性の拡張期血圧を除いて統計的に有意であった。

FIGURE 6 CASE 3, BOTH HIGH-VOLTAGE AND ST-T CHANGES REGRESSION

図6 症例3 高電位差とST-T変化ともに退縮



At age 61, both high-voltage ($Sv1+Rv5=51\text{mm}$) and ST-T changes in V5-6 appeared. At age 65, both high-voltage ($Sv1+Rv5=31\text{mm}$) and ST-T changes disappeared.

61歳で高電位差 ($Sv1+Rv5=51\text{mm}$) と V5-6 における ST-T 変化が出現. 65歳で高電位差 ($Sv1+Rv5=31\text{mm}$) と ST-T 変化の両方が消失した.

TABLE 7 COMPARISON OF BPI CHANGES IN PATIENTS WITH LVH REGRESSION AND THEIR AGE- AND SEX-MATCHED CONTROLS

表7 左室肥大退縮例と年齢・性対照例との血圧指数変化の比較

Parameter	Case	p value for case vs control [†]	Control
Male (n=18)			
Age at bomb (yr)	32.7±2.5		32.1±2.5
SBPI (%)	-3.5±4.0	< .05	1.6±2.5
DBPI (%)	-4.7±2.1	NS	0.8±3.0
Female (n=45)			
Age at bomb (yr)	31.6±1.5		31.4±1.6
SBPI (%)	-3.2±1.6	< .05	3.0±2.6
DBPI (%)	-3.2±1.5	< .05	2.9±2.2
Total (n=63)*			
Age at bomb (yr)	31.9±1.3		31.6±1.3
SBPI (%)	-3.3±1.6	< .001	2.6±2.0
DBPI (%)	-3.7±1.2	< .001	2.3±1.8

SBPI: Systolic blood pressure index, DBPI: Diastolic blood pressure index (see text).

SBPI: 収縮期血圧指数, DBPI: 拡張期血圧指数(本文参照).

*Five cases (three males and two females) were excluded from the total number in Table 6 because they were not age- and sex-matched when the difference in their ages at the time of the bomb was defined less than or equal to five.

5名(男3, 女2)は, 原爆時年齢の差を5歳以下にした場合, 性・年齢が対応しないので, 表6の数から除いた.

[†]Significance probability is calculated on Wilcoxon's rank sum test.

確率の有意性は Wilcoxon の順位差検定を用いて計算した.

DISCUSSION

Several studies indicate that antihypertensive drug treatment has protective effects against the development of ECG-LVH. Successful control of hypertension may be associated with the regression of LVH. The AHS program is designed to diagnostically evaluate a fixed population and is not therapeutically oriented. As a result, the long-term (26 years) natural course of blood pressure and ECG readings are assessable. At present, echocardiography undoubtedly is the most sensitive and specific method for the identification of LVH; this has made it possible to visualize directly left ventricular (LV) wall thickness and chamber dimensions.^{2,12} A relatively weak correlation ($r \doteq 0.60$) was shown between the ECG signs of LVH and angiographic or echocardiographical measurements of the LV mass.¹³⁻¹⁵ The ECG voltage criteria depend on the age, weight, and distance of the left ventricle from the chest wall, and therefore, do not allow an accurate quantification

考 察

降圧剤による治療は心電図左室肥大の進展を予防する効果があるという報告が幾つかある. 高血圧の十分なコントロールは, 左室肥大の退縮に関連するようだ. 成人健康調査の目的は固定集団の診断的評価であり, 治療をめざすものではない. その結果, 長期(26年間)に及ぶ血圧と心電図の自然経過を検討することが可能である. 今日, 左室壁厚と左室径を直接現わすことのできる超音波検査法が最も敏感度, 特異度とも高いことは疑う余地がない.^{2,12} 左室肥大の心電図所見と血管造影や超音波による左室容量の測定値との間には, 比較的弱い相関($r \doteq 0.60$)しかない.¹³⁻¹⁵ 心電図の電位差の基準は, 年齢, 体重, 及び胸壁から左室までの距離に依存し, それゆえ左室

of alterations in the LV mass.¹⁵⁻¹⁷ Various sets of ECG-LVH criteria, such as the classical Sokolow and Lyon criteria,¹⁸ the more elaborate point-scoring system by Romhilt and Estes,¹⁹ or the system of Macfarlane et al²⁰ show poor sensitivity (20%-65%) with an acceptable specificity (84%-100%). Conversely, the present study may have underestimated the frequency of LVH.

In addition, since this is a longitudinal study, the influence of aging on ECG and blood pressure should be taken into consideration. The LV wall thickness has been shown to increase with progressive aging even when blood pressure remains in the normotensive range. Although age-dependent changes increase LV wall thickness by only about 25% between the second and seventh decade.²¹⁻²³ In contrast to wall thickness, LV diastolic diameter did not correlate with age; aging may primarily affect concentric LVH.

In cross-sectional studies,²⁴⁻²⁶ it has been noted that blood pressure increases at a fairly constant rate until age 70s in females, whereas the rate of increase in males during adolescence is faster, but subsequently the increment in males becomes less than that in females. Diastolic blood pressure, in both sexes, increases more gradually with aging. The cross-sectional studies frequently identify a decline in diastolic and, to a lesser extent, systolic blood pressure during the latter part of life (in age 60s). In the longitudinal studies conducted by Kannel and Gordon²⁵ and in the RERF study,²⁷ same tendencies were observed; systolic blood pressure reaches its highest point in age 70s and diastolic blood pressure in age 60s, declining somewhat thereafter. Considering these data as a whole, the decline of systolic and diastolic blood pressures in the course of ECG-LVH regression is meaningful.

In an attempt to evaluate the individual relationship between the ECG-LVH regression and the lowering of blood pressure, the criterion mentioned above was set up (Table 6). About one-half of the cases of ECG-LVH regression might be related to the lowering of blood pressure (Figure 3). What other factors may be associated with LVH regression? Of course, the correlation between LV mass and blood pressure was the strongest when blood pressure was measured during active daily life.²⁸ But in this study, blood pressure was measured only once every two years and was a casual one. Furthermore,

容量の正確な変化を示さない。¹⁵⁻¹⁷ 様々な心電図左室肥大の基準, 例えば古典的な Sokolow 及び Lyon の基準¹⁸ や, 更に精巧な Romhilt 及び Estes による得点加算方式¹⁹ や Macfarlane らによる方法²⁰ では, 鋭敏度は低く (20%~65%), 特異度は評価に耐える程度 (84%~100%) である. 逆にいえば, 今回の研究は左室肥大の頻度を過小評価しているともいえる.

これは長期にわたる研究であり, 心電図と血圧に及ぼす加齢の影響を考慮する必要がある. 左室壁厚は, たとえ血圧が正常範囲にとどまっても加齢につれて増加を示す. もっとも加齢に伴う左室壁厚の変化は, 10~60歳代の間では約25%増加するだけである.²¹⁻²³ 壁厚に比し, 左室拡張期径は年齢と相関しない. 加齢は主に求心性左室肥大と関係しているようである.

一方, 断面的な研究²⁴⁻²⁶ によると, 女性では70歳代まで比較的一定の割合で血圧が上昇するのに対し, 男性では青年期には血圧の上昇が急速であるがその後は女性より低くなる. 拡張期血圧は, 男女ともに加齢に伴う上昇はより緩徐である. 断面的な研究によると, しばしば人生の後半 (60歳代) において拡張期血圧が, また程度はより小さいが収縮期血圧も下がることが知られている. Kannel と Gordon²⁵ や放影研²⁷ の縦断的な研究においても同様な傾向が認められている. すなわち収縮期血圧は70歳代まで, 拡張期血圧は60歳代まで上昇し, それ以後は若干低下する. これらの結果を踏まえて判断すると, 心電図左室肥大の退縮周期における収縮期及び拡張期血圧の低下は意味深い.

心電図左室肥大の退縮と血圧低下の関係を個々の例について評価するために上述した基準を設定した (表6). 心電図左室肥大の退縮の約半分は血圧の低下と関連がありそうである (図3). 左室肥大の退縮に関連する他の因子は何であろうか. もちろん, 血圧測定が日常生活の活動時のものであれば, 血圧値と左室壁厚の関係は非常に強いものである.²⁸ しかし, 今回の研究では血圧は2年に1回の測定であり, しかも随時血圧である. 更に, 容量負荷, ホルモン

modulators of LVH, such as volume load, hormonal factors, and hereditary factors should be considered.

It would appear that the regression of pressure overload occurs at a younger age and a higher level of blood pressure, and is probably correlated with other preceding factors except the reduction of hypertension.

因子、遺伝因子などの左室肥大修飾因子を考慮しなければならぬ。

圧負荷の退縮は、より若年において、しかも高い血圧値で起こることが、そして、おそらく血圧低下以外の何か他の先行する因子との関連があることが示唆された。

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