

(J Tokyo Wom Med Coll)
(67 (3) 139~146 (1997))

APPLICATION OF PLETHYSMOGRAPHY IN THE LONG-TERM MANAGEMENT OF A PATIENT WITH EQUIVOCAL COMPLAINTS: 12-YEAR FOLLOW-UP INCLUDING THE CLIMACTERIC

Toshiko TAKEMIYA, Akemi TANAKA*, Hiromi WATANABE**, Seiko YAMAGUCHI,
Yoko MIURA, Yuko SUGISHITA and Mikiko SHIMIZU

Department of Neurology and *Department of Psychiatry,
Tokyo Women's Medical College

**Department of Medicine, Tokyo Women's Medical College School of Nursing

(Received November 19, 1996)

A patient with varied equivocal complaints of vasomotor disorders, including psychological components that developed during the climacteric, was followed for 12 years. The detailed content of their complaints obtained during patient interviews, and three types of plethysmography findings (finger-tip and toe-tip plethysmography, and its primary differential, i.e., velocity plethysmography, and its secondary differential, i.e., accelerated plethysmography) were applied and assessed, and the conclusions below were obtained. (1) Finger-tip and toe-tip plethysmography findings: There was good consistency between the changes in the clinical manifestations and the finger-tip and toe-tip plethysmography patterns. (2) Finger-tip and toe-tip velocity plethysmography findings: There was good consistency between the clinical manifestations and the finger/toe wave height ratio. (3) Finger-tip and toe-tip accelerated plethysmography findings: The wave pattern is more closely in tandem with the patient's physical condition, and the patient's physical condition was good when the b/a and d/a values were almost the same. There was developed the climacteric disorder during the period when her child became independent, her husband, who had important position in his company and had been completely engrossed in his work, responded to the physician's explanation and request for support by beginning to devote more attention to his wife, and that had the greatest therapeutic effect, leading to the "psychological remarriage" described by Tamaya et al.

Introduction

Clinical testing methods available for vasomotor disorders, which often occur during the climacteric, are limited. Based on long years of clinical experience we have been utilizing finger-tip plethysmography¹⁾⁻³⁾. In this study, however, we measured digital plethysmography (DPG) and their primary differential

(velocity plethysmography; VPG) and secondary differential (accelerated plethysmography; APG), and conducted comparative medical assessments with the course of other clinical test findings and the patient's symptoms.

Detailed interviews regarding the patient's complaints, centering on psychological factors, were also conducted, and an attempt was also made to match them with the plethysmographic

findings.

A discussion of the patient's complaints based on aspects of interpersonal relations between women and family members in today's society is also included.

Methods

Since 1975 we have been using accelerated plethysmographs (a differential analyzer was installed in the Fukuda Electronics PT703 to produce the finger-tip plethysmograph and the recording speed was adjusted).



Fig. 1 Course of the plethysmographic findings
 DPG: The patient's physical condition, both good and poor, is more closely reflected by the toe-tip pulse wave. Her DPG showed always monophasic pattern by the finger-tip pulse wave, but showed in good condition dilated pattern by toe-tip pulse wave (refer to Table 1). DPG wave height is rather higher hypersensitive times. the patient complained of discomfort when the finger-tip wave height were 4.0~4.5 (mV/V), whereas she felt refreshed at 3.0~3.8. When toe-tip wave height was 0.25~0.4, the feeling of coldness was severe. At 1.0 and above the patient was asymptomatic (refer to Table 2).
 VPG: The patient's physical condition was good when the finger/toe ratio was about 2.0. The balance between finger and toe blood flow appear to reflect the patient's physical condition better than either of the wave heights alone (refer to Table 3).
 APG: The finger-tip pulse wave pattern is more closely in tandem with the patient's physical condition. And her condition was good when the b/a and d/a values were almost the same (refer to Table 1, 4, 5).

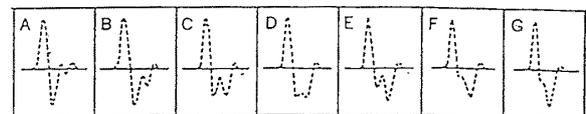
The items listed below were assessed periodically. The plethysmographs were obtained with three methods (DPG, VPG, APG) when this patient aged 50~58 years, with one method (DPG) when she aged 47~49 years.

1. Symptom (in as great detail as possible)
2. Confirmation of clinical signs
3. General clinical studies (ECG, general blood studies, serum biochemistry studies, routine urinalysis, postural changes in blood pressure, etc)
4. Chest X-P (once a year)
5. Plethysmography measures were recorded (refer to Fig. 1)
 - 1) DPG wave patterns and wave height
 - 2) VPG wave height
 - 3) APG wave patterns (ABCDEFG), wave height (abcde) (refer to Fig. 2)

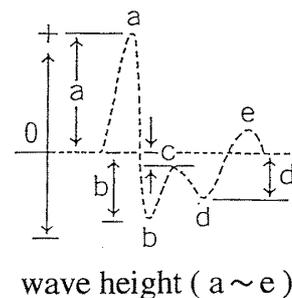
Case Study

1. Patient

The patient is a 58-year-old (1996) full-time homemaker, whose husband holds an important position in his company, and who had a son who has already become independent. Her chief complaint when the first examined 12 years previously was hot flushes, cold extremities, general malaise, insomnia, dull headedness, headaches, irritability, labile blood pressure, palpitations, etc.



wave patterns (A ~ G)



wave height (a ~ e)

Fig. 2 APG

The history of her involvement with the college hospital is as follows. At age 47 she was visiting her family doctor's office almost every day with equivocal complaints, but was told that she had a climacteric disorder, and that nothing could be done except wait until it passed. Disappointed and desiring more aggressive treatment, she was referred to this hospital and was examined.

Her menses became irregular soon after she turned 47 years old (their timing and duration were irregular and had gradually diminished). Menopause occurred at 47 years 11 months, the average age at which menopause occurs in Japan.

The patient's past medical history revealed that she had been treated for tuberculosis at age 25, and her chest X-ray findings were also checked once a year during the course of follow-up.

2. Findings at the time of the initial examination

Blood pressure: 180/80 mmHg; pulse: 100/min, regular; head, neck, thorax, abdomen: unremarkable; extremities cold, skin surface temperature 26~27°C (in a comparison subject of the same sex and age: 30°C). There were no abnormal neurological findings. Chest X-ray revealed old tuberculosis; the 1-hour erythrocyte sedimentation rate was 14 mm/h; the tuberculin reaction was positive; the results of the blood and serum biochemistry studies and urinalysis were normal; the ECG revealed mild ischemic changes (There was no Q wave, only slight ST-T wave depression, and no arrhythmias).

3. Course of the plethysmographic findings

1) DPG

The patient's physical condition, both good and poor, is more closely reflected by the toe-tip pulse wave. Her DPG showed always monophasic pattern by the finger-tip pulse wave, but showed in good condition dilated pattern by toe-tip pulse wave (refer to Table 1).

DPG wave height is rather higher hypersensitive times. The patient complained of discom-

Table 1 DPG and APG patterns

Age (yr)	DPG 2nd finger, right hand	DPG 2nd toe, right foot	APG 2nd finger, right hand	APG 2nd toe, right foot
47	msr	m	—	—
48	msr	msr	—	—
49	msr	sr. dil	—	—
50	msr	sr. dil	C	B
51	msr	sr	E	B
52	msr	sr	D	B
53	msr	sr	E	B
54	msr	sr	D	B
55	msr	sr	D	B
56	msr	sr	D	B
57	msr	sr. dil	D	B
58	msr	sr. dil	C	B

m : monophasic, s : sclerotic, r : rigid, dil : dilated.

APG types "B, C, D, E" are demonstrated similarly in Fig. 2.

The patient's physical condition is more closely reflected by the toe-tip DPG and the finger-tip APG.

fort when the finger-tip wave height were 4.0~4.5 (mV/V), whereas she felt refreshed at 3.0~3.8. When the toe-tip wave height was 0.25~0.4, the feeling of coldness was severe. At 1.0 and above the patient was asymptomatic (refer to Table 2).

2) VPG

The patient's physical condition was good when the finger/toe ratio was about 2.0. The balance between finger and toe blood flow appear to reflect the patient's physical condition better than either of the wave heights alone (refer to Table 3).

3) APG

The finger-tip pulse wave pattern is more closely in tandem with the patient's physical condition. And her condition was good when the b/a and d/a values were almost the same (refer to Table 1, 4, 5).

4. Course of the patient's complaints

Hot flushes: The hot flushes peaked during the year around menopause and stopped completely at age 55.

Cold extremities: The patient's extremities were cold from age 47 to 53, but this symptom repeatedly grew worse and milder with changes

Table 2 DPG wave heights

Age(yr)	2nd finger, right hand	2nd toe, right foot
		(mV/V)
47	3.8	0.8
48	0.3	0.3
49	2.2	0.6
50	4.5	1.3
51	3.3	0.8
52	5.0	0.7
53	3.0	0.8
54	3.8	1.2
55	3.8	1.4
56	3.0	1.0
57	3.0	1.1
58	2.0	0.8

Wave height is rather higher during hypersensitive times. The patient complained of discomfort when the finger-tip waves were 4.5~5.0 (mV/V), whereas she felt refreshed at 3.0~3.8.

When the toe-tip wave height was 0.25~0.4, the feeling of coldness was severe. At 1.0 and above the patient was asymptomatic (all of the values are the lowest values measured that year).

Table 3 VPG wave heights

Age(yr)	2nd finger, right hand	2nd toe, right foot	Finger/toe ratio
			(mV/V)
47	—	—	—
48	—	—	—
49	—	—	—
50	3.5	0.4	8.8
51	1.3	0.6	2.1
52	1.9	0.3	6.3
53	1.5	0.5	3.0
54	1.5	0.7	2.1
55	1.5	0.7	2.1
56	1.4	0.7	2.0
57	1.4	0.7	2.0
58	1.0	0.5	2.0

The patient's physical condition was good when the finger/toe ratio was about 2.0 (mV/V). The balance between finger and toe blood flow appear to reflect the patient's physical condition better than either of the wave heights alone.

in the seasons, without any particular peak being observed. The patient has not complained of cold extremities since she turned 54 years old.

Table 4 APG wave heights

Age (yr)	a	b	c	d	e
					(mV/V)
47	—	—	—	—	—
48	—	—	—	—	—
49	—	—	—	—	—
50	4.8	1.4	0.8	1.2	0.7
51	2.0	0.8	0.0	1.0	0.2
52	2.7	0.8	0.6	1.2	0.6
53	1.8	0.5	0.3	0.8	0.4
54	2.2	0.2	0.1	0.7	0.3
55	1.5	0.3	0.2	0.3	0.3
56	2.0	0.2	0.1	0.2	0.2
57	2.2	0.3	0.1	0.3	0.3
58	1.3	0.3	0.3	0.4	0.2

No correlation was found between the changes in each of "abcde" waves height and changes in the patient's physical condition.

Table 5 -b/a & -d/a

Age(yr)	-b/a	-d/a
47	—	—
48	—	—
49	—	—
50	0.29	0.31
51	0.40	0.50
52	0.29	0.44
53	0.27	0.44
54	0.09	0.32
55	0.20	0.20
56	0.10	0.10
57	0.14	0.14
58	0.23	0.31

b/a recognized an index of arteriosclerosis, d/a recognized as an indicator of the degree of arteriolar functional dilatation. The patient's physical condition was good when the b/a and d/a values were almost the same.

Dull headedness: The dull headedness was worse after nights when the patient was unable to sleep and also became worse before the patient's occasional menses. However, it was never a clearly localized "pain".

Irritability: Irritability almost always occurred in association with insomnia.

Insomnia: The insomnia was mostly governed by psychological factors, and it repeatedly grew worse and better according to her husband's schedule.

Chest discomfort: The chest discomfort closely coincided with the occurrence of cold extremities. The patient tended to complain of chest discomfort more often when her family was at home. It did not progress over the 12-year period, but instead gradually decreased. It decreased sharply from 52 years of age onward, and hardly ever occurs now.

General malaise: The complaints of general malaise stopped about one year after the end of the menopausal period.

Large fluctuations in blood pressure: The changes in blood pressure occurred only for one year during menopause and improved in response to sleep-inducing agents or minor tranquilizers.

Low back pain, arthralgia, stiff shoulders, paresthesia of the hands and feet: The patient complained of low back pain, arthralgia, stiff shoulders, paresthesia of the hands and feet as though she occasionally remembered them, but they improved just by listening, without any special treatment. Recently the patient has been saying that she often goes for walks or performs calisthenics.

5. Summary of the patient's complaints

The complaints that were relatively persistent were those associated with the vasomotor nervous system, consisting of facial flushing, coldness of the extremities, and chest discomfort. Almost all of these complaints stopped about two years after menopause, and at the present time the patient is leading a pleasant, complaint-free life. We requested that she return periodically for the purpose of managing her borderline hypertension, and she is being followed every season, with plethysmography included the clinical tests.

Discussion

1. Clinical application of plethysmography to every patient

While in general there have already been many cross-sectional multiple-patient studies, long-term observation of the same subject is also indispensable to research on the elderly

and climacteric women, in whom there are often individual differences. Particularly in the case reported in this paper, the fact that the examinee, the examiners, the time of the examinations and their duration, and the instruments used were almost always the same can be said to have made comparisons relatively easy.

We started applying plethysmography to clinical examinations in the Department of Internal Medicine of Tokyo Women's Medical College in 1966, and as the instruments improved have repeatedly assessed their interpretation with investigators at other universities. We have been using APG since 1975, making reports, mostly at meetings of the plethysmography-Accelerated Plethysmography Research Society, carrying out comparative assessments with the results at other institutions, and have begun to use interpretation methods on which a consensus has been reached.

DPG, VPG, and APG each has its own characteristics, and we have continued to report on applications in the field of internal medicine⁴⁾, and indicators in the treatment of hypertension⁵⁾ and Raynaud's syndrome⁶⁾. Miura et al compared laser blood flowmetry and finger-tip plethysmography, reported finding a correlation between blood flow measured by the laser flowmeter and both DPG wave height and VPG wave height, and drew up guide-lines for clinical applications that take advantage of the special characteristics of both⁷⁾.

The fact that the b/a value (recognized as an index of arteriosclerosis) and the d/a value (recognized as an indicator of the degree of arteriolar functional dilatation) of the APG at the time the patient's complaints stopped (Table 5) and she felt better in the present study were almost the same appears to mean that this time represented the end of the patient's climacteric and the time to start keeping arteriosclerosis in mind. The same phenomenon has been inferred at the time when arteriosclerosis progresses in cross-sectional multiple-patient

studies^{8)~11)}. This is a very interesting finding, and we intend to continue to investigate it in the future.

Hardly any of the clinical tests currently being performed closely parallel the patients' changing symptoms. The DPG, VPG, and APG pulse waves are useful as methods of easily determining the status of the peripheral circulation, which changes from one minute to the next. While each interpretation has its own characteristics, evaluation methods will not improve by making uniform decisions, but by being innovative based on the principle and investigating digital wave height ratios such as b/a and d/a .

2. Psychological discussion of the case

The couple were both university graduates and married after becoming acquainted through an *o-miai*, a traditional Japanese system of introducing prospective marriage partners. To please her husband and his family, as well as her own, the patient never sought employment and has always been a fulltime homemaker. There was only one child, a boy, who is already married and independent. The patient's husband graduated from a top-ranking university and is an elite white-collar worker. He has climbed up the corporate ladder, and the couple has no financial worries. "Robust" is a fair description of the husband's health. He has never stayed home with a cold and he does not have any feelings of sympathy or consideration for sick people. He seems to have the traditional "breadwinner" life style, even playing business-related golf on his days off, and he is often away from home. The patient led a "devoted wife and good mother" life for more than 30 years, and while keeping in touch with her relatives and neighbors, because of her retiring nature, her life has been relatively free of problems. However, she has hardly any friends that she can confide in or who will pass time with her taking trips, going to shows, and so forth. Nevertheless, when her son was small, because she was quite busy with childrearing, preparation for school, and the like, and she

was spending her time actively engaged, she never had occasion to consult an internist or a psychiatrist.

At 49 years of age, i.e., around the time she was facing the climacteric, her son found employment, married, and moved out of his parents house, and the patient lost her sense of purpose in life. At about that time she started to visit a clinic almost every day. Even then, her husband's life style was still the same, and in fact he was given a promotion to an important position and became busier than ever. Moreover, since her husband's parents did not live with them, there was no need for her to care for them.

The patient's symptoms, particularly her insomnia and the associated dull headedness, headaches, and chest discomfort, etc., often became more severe and improved in tandem with the rhythm of her husband's activities. On days when her husband came home on time and they passed the time together, she did not need to take her medicine and was in good spirits. Although this way of living, with the wife completely dependent on her husband, was very disturbing to the patient, it was impossible to change abruptly. We therefore explained the patient's symptoms to the husband, especially their psychological aspects, and asked for his cooperation. Once he sufficiently understood and adopted a supportive attitude, the amount of sleep-inducing agents and stabilizers the patient took decreased dramatically.

The development of the patient's climacteric disorder during the period when her child was becoming independent served as an occasion for the couple to reconfirm their marital relationship. This appears to represent the so-called "psychological remarriage" proposed by Tamaya¹²⁾.

Generally, in most cases, a marital gap that has been growing wider without couple realizing it (the husband is given an important position at work and does not have the time to only be concerned about his wife's wishes) leads to a divorce or nervous disorders. In our own

patient, the wife's development of climacteric disorders provided an opportunity for diagnosis and treatment that included the patient's marital relationship, and being able to give advice concerning the shape their future life as husband and wife even provided the physician involved with a feeling of satisfaction from both an internal medical and a psychiatric standpoint.

Experience with actual cases, as with this patient, has been becoming more common, and practical psychiatric knowledge concerning women is likely to become even more important in the future¹³⁾.

Conclusion

The clinical manifestations and plethysmographic findings were periodically checked over an 12-year period, from age 47 to 58, in a female patient with equivocal complaints, and the following results were obtained.

DPG: The changes in clinical manifestations and toe-tip plethysmography patterns closely paralleled each other.

VPG: The changes in clinical manifestations and finger/toe wave height ratios closely paralleled each other.

APG: The changes in clinical manifestations and finger-tip pulse wave patterns and balance between b/a and d/a closely paralleled each other.

When it is impossible to measure all three pulse waves simultaneously, we recommend an interpretation method that makes the best use of the characteristics of each of them in terms of the clinical purpose.

In regard to this patient we would particularly like to emphasize that it was insufficient to simply listen to her tales of multiple climacteric complaints and accept them, but that it was necessary to collect as much objective evidence as possible, provide symptomatic treatment, and actively solicit the support and cooperation of the family.

References

- 1) **Takemiya T:** Clinical application of digital plethysmogram. *J Tokyo Wom Med Coll* **46**(1): 1-12, 1975
- 2) **Takemiya T:** Pathophysiology and treatment of vasomotor disturbance of extremities. *Neurol Therapy* **3**(3): 243-249, 1986
- 3) **Ito A, Takemiya T, Yamaguchi H et al:** Study of autonomic nervous disturbance —complaints and plethysmographic findings (DPG, APG)—. *J Tokyo Wom Med Coll* **59**(6): 620-627, 1989
- 4) **Takemiya T, Yamaguchi H, Miura A et al:** Clinical study of peripheral plethysmography: The application and possibilities of plethysmograph in medical neurology. *J Tokyo Wom Med Coll* **59**(6): 461-467, 1989
- 5) **Takemiya T, Sugishita Y, Itoh A et al:** Raynaud's syndrome. *J Tokyo Wom Med Coll* **60**(12): 989-998, 1990
- 6) **Takemiya T, Shimizu M, Yamaguchi H et al:** Effects of dilevalol in hypertension assessed by digital pulse plethysmography. *Clin Ther* **14**(3): 385-389, 1992
- 7) **Miura Y, Yamauchi T, Sugishita Y et al:** Comparison of laser-Doppler measurement with photoelectric digital plethysmography: under the basal condition and mental arithmetic, deep inspiration. *J Tokyo Wom Med Coll* **62**(12): 1608-1614, 1992
- 8) **Fujinuma H, Suzuki A, Kawai H et al:** The b wave and severity of carotid artery sclerosis. Records of the 4th Meeting of the Accelerated Plethysmography Society: 17-26, 1986
- 9) **Suzuki A, Fujinuma H, Sudo H et al:** Arteriosclerotic disease and accelerated plethysmography. Collected Papers Presented at the 9th Meeting of the Accelerated Plethysmography Society: 25-35, 1990
- 10) **Oda K, Takazawa K, Maeda K et al:** b/a and aging. Collected Papers Presented at the 11th Meeting of the Accelerated Plethysmography Society: 27-36, 1991
- 11) **Shiota M, Iguchi T, Ono K et al:** Peripheral circulatory organs and vascular elasticity. Collected Papers Presented at the 12th Meeting of the Accelerated Plethysmography Society: 41-46, 1991
- 12) **Tamaya N:** Middle-age crisis in women, its meaning, and future tasks. *In the Middle-Age Mind* (Ujihara H ed) Baifukan, Tokyo (1992)
- 13) **Kamo T, Tamura A:** Women and family in modern Japan. *Rinsho Seishin Igaku* **25**(8): 933-939, 1996

不定愁訴例の長期管理における脈波の応用

—更年期を含む12年間の経過観察—

東京女子医科大学 神経内科学教室

*同 精神医学教室

**同 看護短期大学 内科学教室

タケミヤ トシコ タナカ アケミ ワタナベ ヒロミ ヤマグチ セイコ
 竹宮 敏子・田中 朱美* ・渡辺 弘美**・山口 晴子
 ミウラ ヨウコ スギシタ ユウコ シミズ ミキコ
 三浦 庸子・杉下 裕子・清水 幹子

更年期に発症した精神的要素を含む、多彩な血管運動調節障害性不定愁訴の症例を12年間経過観察し、愁訴の詳細な聴取による内容と3種の脈波所見（指趾先容積脈波・その一次微分即ち速度脈波・その二次微分即ち加速度脈波）を対応させて検討し、下記のような結論を得た。

- (1) 指趾先容積脈波所見：症候と趾先容積脈波パターンの動きはよく一致した。
- (2) 指趾先速度脈波所見：症候と指/趾の波高比の動きはよく一致した。
- (3) 指趾先加速度脈波所見：症候と指先脈波パターン、 b/a と d/a 均衡度の変化はよく一致した。

必ずしも常に3種類の脈波を揃える必要はなく、临床上の目的に応じて、それぞれ特徴のある脈波の判読法が活用されるよう勧めた。

本例の精神的变化の背景因子を検討し、子供の自立期に発症した妻の更年期障害を契機に、夫はそれまで会社の重要な地位で仕事にだけ向いていた目を、主治医の説明と支援要請で改めて妻に向け始め、玉谷らの主張する「心理的再婚」に到達し、このことがなによりの治療効果を上げたことも強調した。