Parameters for evaluating the existence of uric acid crystals in a Human Body

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Several parameters for evaluating the existence of uric acid crystals are experimentally examined. As a primary parameter, R is effective for evaluating the existence of uric acid crystals. As secondary parameters, N_c, $P_{max}(0^-,2)$, and N/P are effective for evaluating the flexibility of a blood vessel, and R_{12}/R_6 is also effective for expressing the uniformly flow of uric acid crystals.

Index Terms — Uric acid crystals, Parameters for evaluating the existence of uric acid crystals

1. Introduction

A Method for Measuring the Flexibility of Blood Vessels Using a Blood Pressure Meter has been already reported [1]. In this paper, the small change ΔP_{max} of the arterial systolic maximum value P_{max} of blood pressure was linearly approximated in the following form :

$$\Delta P_{max} = F(T + \Delta T, \rho + \Delta\rho) - F(T, \rho) \cong [-\frac{\partial P_{max}}{\partial T}]\Delta T + [\frac{\partial P_{max}}{\partial \rho}]\Delta\rho . \qquad (1)$$

Where, $P_{max} = F(T, \rho)$, T is the body temperature of a measured subject person, ΔT ($\Delta T \geq 0$) is the small change of the body temperature, ρ is the density of uric acid crystals flowing in the blood vessel, and $\Delta\rho$ is the small change of the density of uric acid crystals.

In a present note, several parameters for evaluating the existence of uric acid crystals using the method described above will be experimentally examined.

2. Method

Fig.1 shows the method for measuring the existence of uric acid crystals in a human body by the heat stimulation. In this method, a rectangular-wave form $H(t)$ expressed as a function of time t is used for the stimulation as shown in **Fig.1 (a)**. Maximum blood pressures P_{max} $(t = 0^-, 0^+, 2, 4, 6, 8, 10, 12)$ (minutes) are measured by using a blood pressure meter, and ΔP_{max} $(t = 2, 4, 6, 8, 10, 12)$ are calculated as shown in **Table 1**. **Fig.1 (b)** is a response waveform of $\Delta P_{max}(t)$.

3. Parameters for evaluating the existence of uric acid crystals

For evaluating the existence of uric acid crystals, the following parameters are used:

(1) As a primary parameter:

$R = R_{12} = A_{12} / (P_{max})_{0^-}$. Where $A_{12} = \sum_{t=2}^{12} \left| (\Delta P_{max})_t \right|$, $(P_{max})_{0^-}$ is an initial value of blood pressure counted as $t = 0^-$, and this is calculated as an average value for three times measurements.

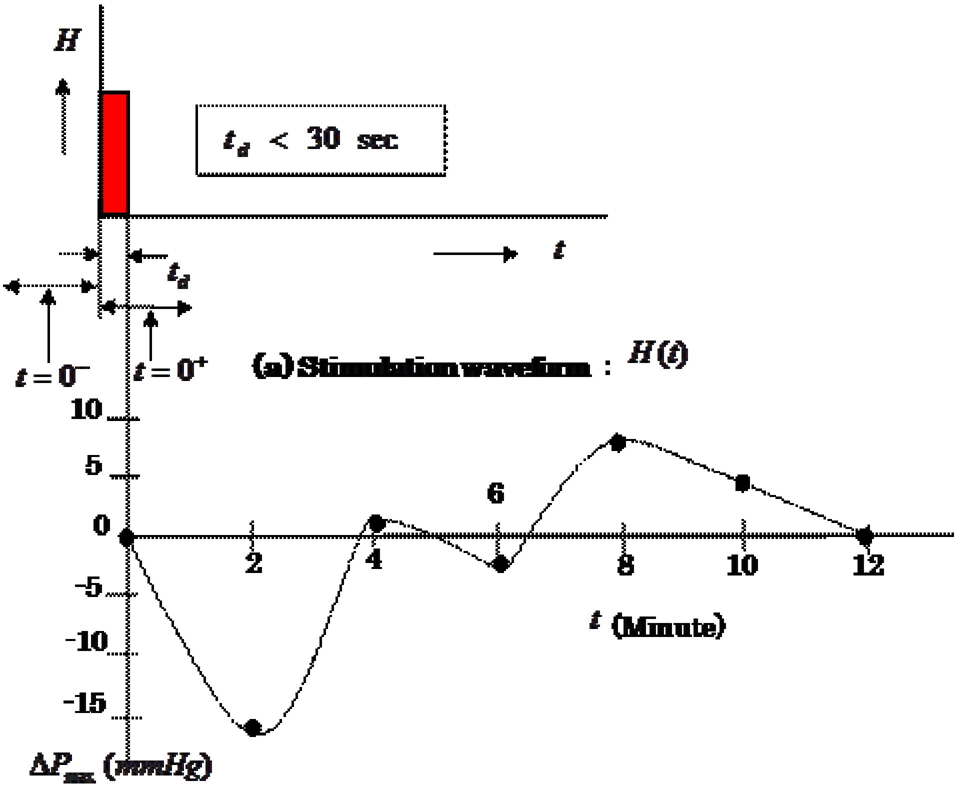
Table1 An example of $H(t)$ and $\Delta P_{max}(t)$

$P_{max}(t = 0^-, 2, 4, 6, 8, 10, 12) = (131, 115, 116, 113, 121, 125, 125)$
$\Delta P_{max}(t = 2, 4, 6, 8, 10, 12) = (-16, +1, -3, +8, +4, 0)$

For example, from **Table 1**, R is calculated as follows:

$$R = R_{12} = {A_{12}}\Big/{(P_{max})_{0^-}} = {32}\Big/{131} = 0.244 \quad . \quad A_{12} = \sum_{t=2}^{12} \left|(\Delta P_{max})_t\right| = 32 \quad .$$

This value expresses the flexibility of a blood vessel, when the Equation (3) shown in Reference (1) is satisfied.



(b) Response waveform : $\Delta P_{\text{[illegible]}}(t)$

Fig, 1 Stimulation and its response waveforms

(2) The number N_C of changes for the sign of $(\Delta P_{max})_i$.

In this case, from **Fig.1 (b)**, N_C =4.

This value also expresses the flexibility of a blood vessel. From many experimental results, N_C =4 is an appropriate value. Generally, this has following relations: $1 \le N_C \le 5$.

(3) The ratio: $\frac{R_{12}}{R_5} = \frac{A_{12}}{A_5}$.

This parameter expresses a uniformly flow of uric acid crystals.

As an example, from **Table 1** and (1), $\frac{R_{12}}{R_5} = \frac{32}{20} = 1.6$.

Where $A_5 = \sum_{i=2}^{5} \left| (\Delta P_{max})_i \right| = 20$, $A_{12} = \sum_{i=2}^{12} \left| (\Delta P_{max})_i \right| = 32$

In this case, it is not a uniform flow. An example of uniformly flow is shown in **Table 3**.

(4) From **Equation** (1), the following three cases can be obtained:

(i) If $[\frac{\partial P_{max}}{\partial T}]\Delta T < [\frac{\partial P_{max}}{\partial \rho}]\Delta \rho$, then $\Delta P_{max} > 0$,

(ii) If $[\frac{\partial P_{max}}{\partial T}]\Delta T = [\frac{\partial P_{max}}{\partial \rho}]\Delta \rho$, then $\Delta P_{max} = 0$,

(iii) If $[\frac{\partial P_{max}}{\partial T}]\Delta T > [\frac{\partial P_{max}}{\partial \rho}]\Delta \rho$, then $\Delta P_{max} < 0$.

These three examples are shown in Table 2

Table 2. An example of Equations (i), (ii), and (iii)

$\Delta P_{max}(0^-,2)$ (mmHg)	$P_{max}(t)$ (mmHg), t (Minute)							R	N_C
	0^-	2	4	6	8	10	12		
>0	117	121	107	108	106	116	103	0.376	5
$=0$	121	121	112	112	117	112	115	0.181	3
<0	129	120	110	110	106	110	113	0.233	4

From Table 1, $\Delta P_{max}(t=2)=-16$.

Where $\Delta P_{max}(2)=P_{max}(2)-P_{max}(0^-)=115-131=-16$.

This result corresponds to a case (iii).

$$\frac{N}{P}=\frac{\sum_{t=2}^{12}\left|\Delta P_{max}(t)\langle 0\right|}{\sum_{t=2}^{12}\Delta P_{max}(t)\rangle 0} \qquad (5)$$

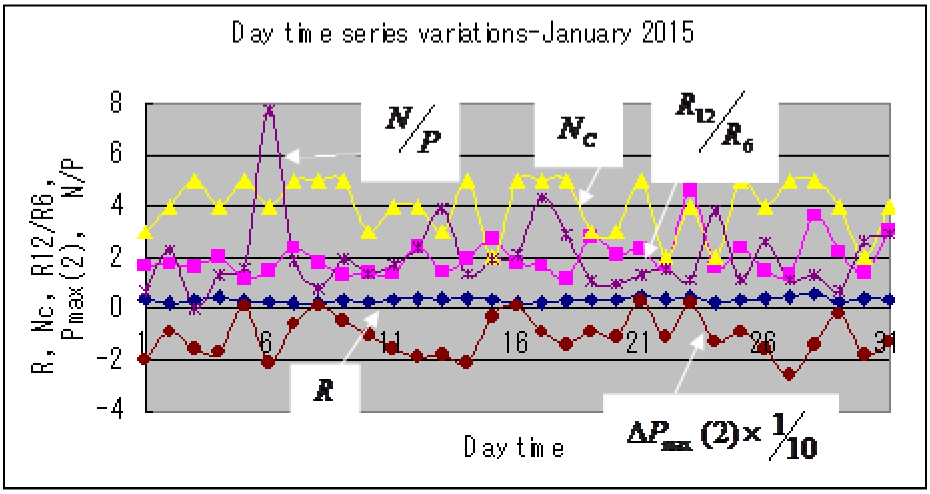
This value expresses the flexibility of a blood vessel.

From Table 1, $\Delta P_{max}(t=2,4,6,8,10,12)=(-16,+1,-3,+8,+4,0)$, $N=19$, $P=13$,

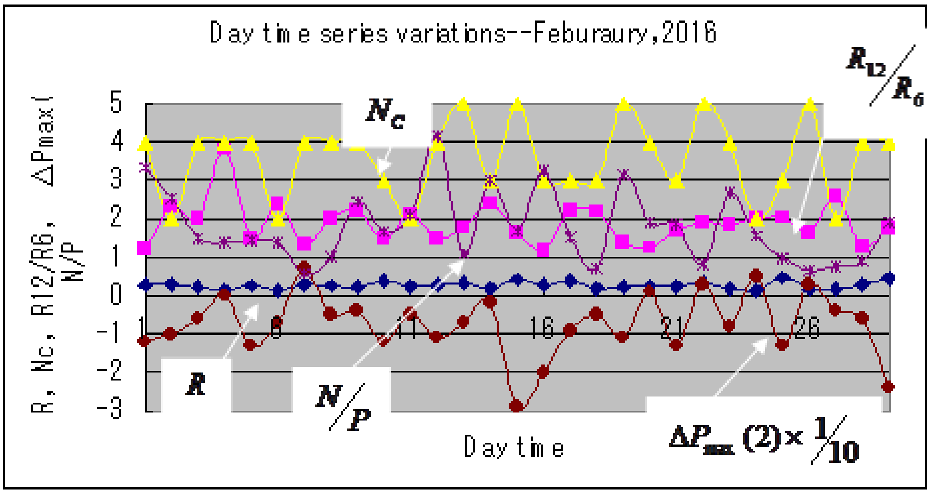
$$\frac{N}{P}=1.46$$

4. Day-Time Series Variations of Parameters

Fig.2 are graphs which express the day- time series variations of R, N_c, R_{12}/R_6, $\Delta P_{max}(2)$, and N/P.



(a) January 1-31, 2015

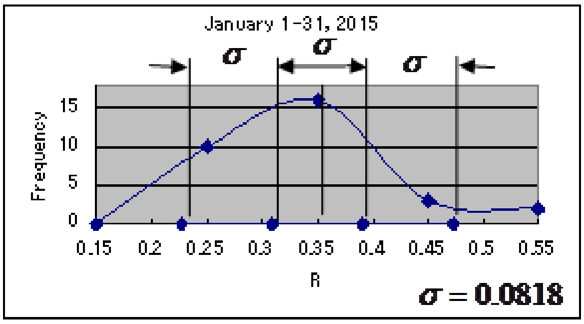


(b) February 1-29,2016

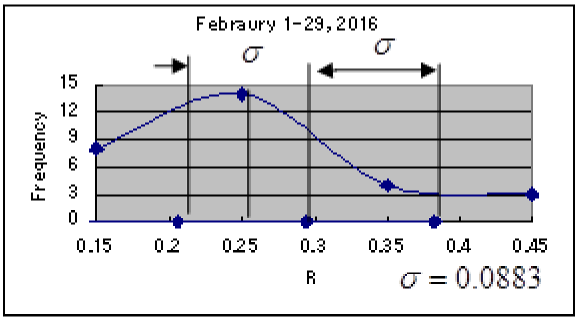
Fig. 2 Day-time series variations of R , Nc , R12/R6, ΔPmax(2), and N/P

Fig.3 shows frequency distribution curves for R. In this figure, σ expresses the standard deviation.

As evidently from the results shown in Fig.3, the average value of R shown in **Fig.3 (b)** is decreased in comparison with that of R shown in **Fig.3 (a)**.



(a) January, 2015



(b) February, 2016

Fig.3 Frequency Distribution Curves

Typical values of parameters are shown in **Table 3**. In this table, $R_{12}/R_6=2$ is a uniform flow.

Table 3 A typical example of parameters

R	Nc	R_{12}/R_6	N/P	Date
0.256	4	2	1	February 8, 2016

5. Conclusion

The parameters for evaluating the existence of uric acid crystals in human body are proposed. In these parameters, a most effective parameter is the prime parameter R. This result may be able to use as an index for healthcare.

Reference :

[1] Keiji Taniguchi, Hiroshi Yamamoto, Ningfeng Zeng, and Kengo Kashihara :
A Method for Measuring the Flexibility of Blood Vessels Using a Blood Pressure Meter, The BWW Journal, July-August 2015