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VISUALIZATION AND QUANTITATIVE ANALYSIS OF PULSE DIAGNOSIS IN AYURVEDA – IIIrd REPORT

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ABSTRACT: *The findings of the Nadi Vijnana of 53 asymptotic adult males were compared with the results of the radial pulse pressure wave analysis by Fourier analysis and 1st differentiation of the original waves. There are significant differences of height and latency of peaks among some pulse diagnosis findings. The possibility to calculate the Dosa balance and the conditions of Subdosa Dhatu of the body with the analysis of radial pulse waves by machine was suspected.*

INTRODUCTION

Many traditional machines such as Chinese and Tibetan Medicine have established the pulse diagnostic systems which detect the abnormalities of organs of both now and future, the mechanism of drug effect, human constitution, his character and his destination.

In this history of traditional medicine, the first description about pulse diagnosis was seen in the papyrus of the Egyptian era[1]. Especially the Chinese book about pulse diagnosis named "MAI JING" written by Wang Shu He in 3rd century described the pulse diagnosis in detail systematically.

The pulse diagnosis of Ayurveda have also the same useful diagnostic system[1]. In India, the word 'Nadi' was described in the classical textbook, Charaka Samhita[1]. In 12th or 13th century, the Sharngadhara Samhita named the science of pulse diagnosis as Nadi Vijnana. The origin of Nadi Vijnana is speculated to be from the Upanishad or Tantra or Yoga, or Siddha medicine of Southern India[1], but thereafter it was systematized in India with the influence from the Chinese medicine.

There have been few researches on the Nadi Vijnana especially from the standpoint of the Modern medicine[1]. We diagnosed the physiological conditions of our body according to the Nadi Vijnana and compared these findings with the results by the radial pulse pressure wave analysis. Many characteristic features of the Tridosa and other Ayurvedic conditions were obtained and the unification of the Nadi Vijnana with the Modern medicine were speculated.

Methods
[Methods of Nadi Vijnana]

The concrete methods to feel the radial pulse was according to Dr.Jaya Ramanuja Raju (World center for perfect health, Maharishi Nagar, Ghaziabad, U.P. India) and Dr. Vasant Lad[2].

Three figures from the second to the fourth are put on the 1 finger breadth inner than radial process side by side without no gap. Right pulse is felt in male, but left one is felt in female. The pulse is felt from the superficial level to the deepest one. As a rule, Vata pulses are felt strongest on the second finger, Pitta pulses on the third finger, Kapha pulses are felt strongest on the fourth finger[2,7]. The superficial pulse balance as well as the deepest pulse balance were studies by one examiner.

The superficial pulses indicate the present balance of Tridosa, the deepest ones tell the constitution (Prakrti). The imbalance between the superficial and deepest pulse is called "Vikrti" the pathological conditions[7].

In the middle level between superficial and deepest one, the conditions of Dhatu can be palpated. The prominent Rakta Dhatu accentuates the strength at only the third fingertip, the prominent Rasa Dhatu accentuates the strength at the third and fourth fingertips equally as if one pulse. On the other hand the prominent. Asthi Dhatu accentuates the strength of the second and third fingertips equally as if one pulse.

Furthermore it is said that the pulses felt on the 4 divided parts of each fingertips indicate the conditions of Subdosa (subdivisions of each Dosa) which reflect more detail conditions of our body[6,8].

[Subdosa felt on each fingers]

Second finger : Prana Vayu, Udana, Samana, Apana Vyana (even pulse in 4 portions)
Third finer : Pacaka Pitta, Ranjaka, Sadhaka, Alochaka, Bhrajaka (even on 4 portions)
Fourth finger : Kledaka Kapha, Avalambaka, Bodhaka, Tarpaka, Slesaka (ven in 4 portions)

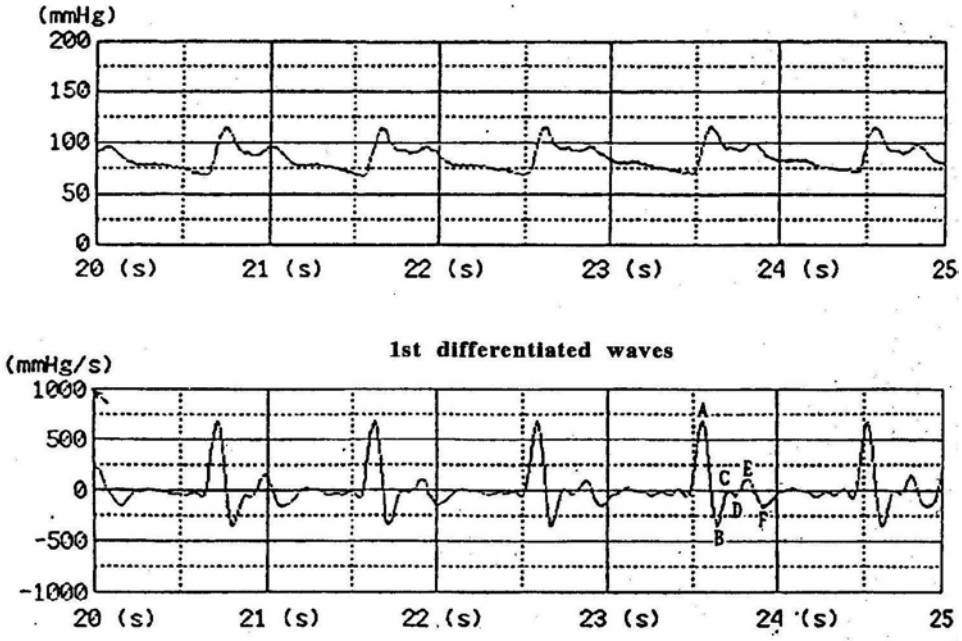
Subjects and methods of modern medical examinations.

Asymptomatic 53 adult males (age; 26-46, Japanese men) were studied by one examiner twice in two weeks according to the Nadi Vijnana after 15 minutes' rest in the sitting position in the air conditioned room at 22.0 – 24.5 centigrade and 30 – 45% humidity on from 15th April to 25th May. They answered some questionnaires such as past medical history, height, body weight and so on. Immediately after the Nadi Vijnana their right radial pulses were recorded by the tonometry type auto-sphygmomanometer[3,5] (NIPPON COLIN Medical Co. JAPAN) for 82 seconds as well as by pulse wavekorotokov sound recorder[6] (PARAMATEK CO. JAPAN) at the left upper limb three times in the sitting position (to know blood pressure, stroke volume and cardiac index) and blood total cholesterol, triglyceride, HDL-cholesterol, GPT, plasma adrenalin noradrenalin and cortisol level) at the same time for each persons during 9:45 – 12:30 in the fast state.

Methods of analysis of the radial pulse pressure waves

The radial pressure waves (analogue data) recorded by the tonometry type auto-sphygmomanometer were transformed by A/D convertor, then fed to the floppy disks every 10mm seconds. The original pulse waves were 1st differentiated and the height and latency of peaks and notches were measured for 5 pulses in the display of NEC 98 series personal computers.

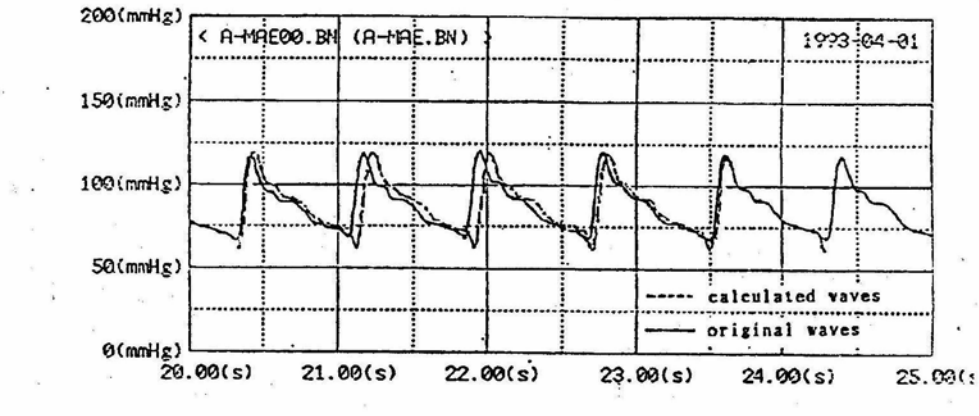
Fig.1 1st differentiation of the original radial pulse waves



The height and latent time of the peaks from A to F were measured for 5 pulse waves. The average from 4 data were shown.

The summed average waves from 5 pulses were analysed by the Fourier transformation to know the amplitude and phase of each harmonized constituent waves. The amplitudes were expressed as the normalized values by the first basic harmonic component. The phases of each harmonics were expressed as the degrees.

Fig 2. Comparison the original radial pressure waves with the calculated waves obtained from the reverse Fourier transformation



Results

1. The characteristic features of the typical pulses which were diagnosed by Nadi Vijnana.

The typical cases which shown the typical superficial pulse of the Tridosa by the Nadi Vijnana were analysed to detect the

characteristic features of the radial pulse for each of Tridosa (superficial Kapha pulse [K pulse], superficial Vata pulse [V pulse] and superficial Pitta pulse [P pulse]). Out of these cases, characteristic features of the deep Pitta pulse cases (superficial Kapha and deep Pitta pulse [K/P pulse], superficial Vata and deep Pitta [V/P pulse], superficial Pitta and deep Pitta pulses [P/P pulse]) were also analysed according to the same methods.

Ranjaka (+) pulse means that Ranjaka Pitta is prominent by the Nadi Vijnana. Prana (+) pulse means the same meanings that Prana Vayu is prominent. Vyana (+) pulse means also that the Vyana Vayu is prominent. Rakta Dhatu, Asthi Dhatu and Rasa Dhatu means the same. R(+), V(+) pulse means that both of Ranjaka Pitta and Vyana Vayu are prominent, opposite of R(-), V(-) pulse, which neither of Ranjaka Pitta nor Vyana Vayu are prominent.

As the results, superficial Vata pulses (V pulse, n=50, age 32.3) had significantly shorter latency of E peak and smaller phase of 7^{th} harmonics than superficial Kapha pulses (K pulse, n = 11, age 34.7) ($p<0.05$) and larger phase of 8^{th} harmonics than superficial Pitta (P Pulse, n=13, age 33.3).

V/P pulses had smaller height of E peak than P/P pulses.

Prana prominent pulses (n=41, age 32.4) had larger height of C peak and 2^{nd} harmonics/1^{st} harmonics ration by the Fourier spectral analysis than Prana negative pulses (n=61, age 32.4) ($p<0.05$).

Vyana Vayu prominent pulses (n=47, age 32.3) had smaller height of B peak and E peak than Vyana negative pulses n-55, age 31.4).

R(-), V(+) pulses had smaller height of peak F and 2^{nd} harmonics/1^{st} harmonics than R(+), V(+) pulses and R(+), V(-) pulses. And R(-), V(+) pulses had larger 2^{nd} harmonics/1^{st} harmonics and smaller phase of 7^{th} harmonics that R (-), V(-) pulses.

Rasu Dhatu prominent pulse (n=6, age 31.2) had larger height of peak B and smaller height of peak D, 4^{th} harmonics / 1^{st} harmonics, phase of 3^{rd} and smaller phase of 7^{th}, 8^{th} harmonics than both Rakta Dhatu (n=52, age 32.3) and Asthi Dhatu prominent pulses (n=7, age 32.2) (p,0.05) Rasa Dhatu prominent pulses had larger phase of 2^{nd} harmonics than Rakta Dhatu prominent pulses ($p<0.05$).

Asthi Dhatu prominent pulses had larger height of peak C, 2^{nd} harmonics / 1^{st} harmonics smaller phase of 5^{th} harmonics than Rasa Dhatu prominent pulses ($p<0.05$) and larger 2^{nd} and 3^{rd} harmonics / 1^{st} harmonics smaller phase of 4^{th},5^{th} harmonics than Rakta Dhatu prominent pulses ($p<0.05$).

The results were summarized in the Table 1 to Table 3.

V pulse : Vata pulse K pulse : Kapha pulse P pulse : Pitta pulse V/P : superficial Vata and deep Pitta K/P : superficial Kapha and deep Pitta, P/P : superficial Pitta and deep Pitta.

Significance levels are shown in the tables, were according to the student's t-test of Welch's method.

R(+) : Ranjaka (+) pulse, V (+) : Vyana (+) pulse

R(-) : Ranjaka (-) pulse, V(-) : Vyana (-) pulse.

Table – 1.1

The characteristic features of the typical pulse of the superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Height and latency of peaks and notches in the 1st differentiated waves obtained from the original radial pressure pulse waves.

	N.	Age	Latency of E (mmsec)	Ht of B (mmHg/sec)	Ht of C (mmHg/sec)
V pulse	50	32 ± 3	339 ± 17	-268 ± 82	- 118 ± 72
			0.02		
K pulse	11	34 ± 7	354 ± 12	-243 ± 60	-115 ± 74
P pulse	13	33 ± 3	343 ± 29	-289 ± 118	-115 ± 78
V/P pulse	46	32 ± 4	338 ± 18	-267 ± 87	-123 ± 72
K/P pulse	6	31 ± 4	342 ± 10	-290 ± 59	-108 ± 60
P/P pulse	11	33 ± 3	338 ± 29	-318 ± 107	-137 ± 62
Ranjaka (+)	76	31 ± 4	342 ± 20	-285 ± 97	-114 ± 76
Ranjaka (-)	26	33 ± 4	344 ± 16	-268 ± 74	- 118 ± 75
Prana (+)	41	32 ± 4	344 ± 18	-283 ± 88	-113 ± 82
					0.05
Prana (-)	61	32 ± 4	342 ± 21	-279 ± 94	-103 ± 68
Vyana (+)	47	32 ± 3	344 ± 23	-257 ± 84	-110 ± 69
				0.02	
Vyana (-)	55	31 ± 4	342 ± 16	-301 ± 93	-119 ± 81
R (+), V (+)	38	32 ± 3	344 ± 25	-264 ± 90	-113 ± 70
R (-), V (-)	17	33 ± 4	344 ± 22	-289 ± 87	-128 ± 73
R (-), V (+)	9	33 ± 3	344 ± 17	-228 ± 46	-100 ± 63
R (+), V (-)	38	31 ± 4	341 ± 15	-306 ± 99	-116 ± 82
Rakta Dhatu	52	32 ± 3	344 ± 19	-274 ± 96	-104 ± 77
Asthi D.	7	32 ± 2	336 ± 22	-296 ± 38	-161 ± 51
				0.03	
				0.06	0.03
Rasa D.	6	31 ± 2	351 ± 22	-366 ± 69	-57 ± 87

Table – 1.2

The characteristic features of the typical pulse of the superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Height and latency of peaks and notches in the 1st differentiated waves obtained from the original radial pressure pulse waves.

	N.	Age	Ht of D (mmHg/sec)	Ht of E (mmHg/sec)	Ht of F (mmHg/sec)
V pulse	50	32 ± 3	-169 ± 51	96 ± 43	- 116 ± 27
K pulse	11	34 ± 7	-167 ± 56	86 ± 35	-111 ± 17
P pulse	13	33 ± 3	-164 ± 63	114 ± 58	-124 ± 43
V/P pulse	46	32 ± 4	-174 ± 55	97 ± 43	-113 ± 23
K/P pulse	6	31 ± 4	-169 ± 46	115 ± 35 (0.04)	-129 ± 11
P/P pulse	11	33 ± 3	-169 ± 66	130 ± 50	-134 ± 39
Ranjaka (+)	76	31 ± 4	-167 ± 61	109 ± 56	-124 ± 34
Ranjaka (-)	26	33 ± 4	-161 ± 45	92 ± 38	- 115 ± 26
Prana (+)	41	32 ± 4	-175 ± 56	107 ± 58	-120 ± 34
Prana (-)	61	32 ± 4	-159 ± 58	102 ± 48	-122 ± 32
Vyana (+)	47	32 ± 3	-170 ± 56	94 ± 43 (0.06)	-116 ± 27
Vyana (-)	55	31 ± 4	-161 ± 58	113 ± 57	-126 ± 36
R (+), V (+)	38	32 ± 3	-172 ± 59	98 ± 45	-119 ± 30
R (-), V (-)	17	33 ± 4	-160 ± 55	99 ± 43	-120 ± 30 (0.04)
R (-), V (+)	9	33 ± 3	-162 ± 47	80 ± 32	-106 ± 9 (0.003)
R (+), V (-)	38	31 ± 4	-162 ± 63	119 ± 63	-129 ± 38
Rakta Dhatu	52	32 ± 3	-168 ± 59	102 ± 50	-120 ± 34
Asthi D.	7	32 ± 2	-179 ± 31 (0.01) (0.003)	107 ± 31	-119 ± 14
Rasa D.	6	31 ± 2	-102 ± 36	119 ± 34	-132 ± 35

Table – 2.1

The characteristic features of the typical pulse of the superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Normalized amplitude of each constituent harmonized waves obtained from the Fourier analysis of the original radial pulse pressure waves

	N.	Age	2^{nd} har./1^{st} harm.	3^{rd} har. / 1^{st} harm.	4^{th} har. / 1^{st} harm.
V pulse	50	32 ± 3	0.63 ± 0.10	96 ± 43	- 116 ± 27
K pulse	11	34 ± 7	0.57 ± 0.06	0.56 ± 0.09	0.28 ± 0.07
P pulse	13	33 ± 3	0.60 ± 0.09	0.55 ± 0.08	0.30 ± 0.08
V/P pulse	46	32 ± 4	0.63 ± 0.10	0.58 ± 0.13	0.30 ± 0.07
K/P pulse	6	31 ± 4	0.64 ± 0.11	0.56 ± 0.09	0.28 ± 0.07
P/P pulse	11	33 ± 3	0.61 ± 0.09	0.59 ± 0.06	0.30 ± 0.06
Ranjaka (+)	76	31 ± 4	0.61 ± 0.09	0.62 ± 0.10	0.31 ± 0.07
Ranjaka (-)	26	33 ± 4	0.60 ± 0.10	0.57 ± 0.10	0.29 ± 0.07
Prana (+)	41	32 ± 4	0.59 ± 0.08	0.56 ± 0.08	0.28 ± 0.06
			0.02		
Prana (-)	61	32 ± 4	0.64 ± 0.11	0.57 ± 0.10	0.29 ± 0.07
Vyana (+)	47	32 ± 3	0.60 ± 0.08	0.57 ± 0.10	0.28 ± 0.06
Vyana (-)	55	31 ± 4	0.62 ± 0.10	0.54 ± 0.09	0.28 ± 0.07
R (+), V (+)	38	32 ± 3	0.61 ± 0.09	0.59 ± 0.11	0.29 ± 0.07
			0.003		
R (-), V (-)	17	33 ± 4	0.63 ± 0.120	0.54 ± 0.08	0.28 ± 0.06
			0.03	0.57 ± 0.07	0.28 ± 0.05
R (-), V (+)	9	33 ± 3	0.55 ± 0.03	0.55 ± 0.10	0.28 ± 0.08
			0.001		
R (+), V (-)	38	31 ± 4	0.62 ± 0.10	0.60 ± 0.12	0.30 ± 0.07
Rakta Dhatu	52	32 ± 3	0.60 ± 0.09	0.56 ± 0.10	0.27 ± 0.05
				0.04(Welch)	
			0.02		
Asthi D.	7	32 ± 2	0.69 ± 0.10	0.61 ± 0.04	0.27 ± 0.04 — 0.0001
			0.02		0.02
Rasa D.	6	31 ± 2	0.55 ± 0.04	0.62 ± 0.11	0.37 ± 0.07

Table – 3.1

The characteristic features of the typical pulse of the superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Phase of each constituent harmonized waves obtained from the Fourier analysis of the original radial pulse pressure waves.

	N.	Age	Phase of 1st harm.	Phase of 2nd harm.	Phase of 3rd harm.
V pulse	50	32 ± 3	343 ± 12 degrees	318 ± 10 degrees	217 ± 20 degrees
K pulse	11	34 ± 7	340 ± 23	320 ± 10	283 ± 17
P pulse	13	33 ± 3	346 ± 4	323 ± 9	278 ± 13
V/P pulse	46	32 ± 4	345 ± 5	319 ± 11	272 ± 21
K/P pulse	6	31 ± 4	346 ± 5	323 ± 9	275 ± 19
P/P pulse	11	33 ± 3	347 ± 3	325 ± 8	277 ± 14
Ranjaka (+)	76	31 ± 4	345 ± 10	322 ± 11	275 ± 18
Ranjaka (-)	26	33 ± 4	342 ± 15	320 ± 8	273 ± 19
Prana (+)	41	32 ± 4	344 ± 13	321 ± 11	272 ± 19
Prana (-)	61	32 ± 4	344 ± 11	321 ± 10	277 ± 18
Vyana (+)	47	32 ± 3	342 ± 16	320 ± 10	276 ± 19
Vyana (-)	55	31 ± 4	346 ± 4	32 ± 11	274 ± 18
R (+), V (+)	38	32 ± 3	343 ± 13	320 ± 10	276 ± 19
R (-), V (-)	17	33 ± 4	346 ± 4	320 ± 7	271 ± 19
R (-), V (+)	9	33 ± 3	334 ± 25	318 ± 10	276 ± 16
R (+), V (-)	38	31 ± 4	346 ± 4	323 ± 12	275 ± 18
Rakta Dhatu	52	32 ± 3	343 ± 15	320 ± 9	274 ± 16
Asthi D.	7	32 ± 2	345 ± 4	320 ± 5	263 ± 13
Rasa D.	6	31 ± 2	348 ± 5	326 ± 7	294 ± 19

0.04

0.01

0.01

Table – 3.2

The characteristic features of the typical pulse of the superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Phase of each constituent harmonized waves obtained from the Fourier analysis of the original radial pulse pressure waves

	N.	Age	Phase of 4st harm,	Phase of 5nd harm.	Phase of 7rd harm.
V pulse	50	32 ± 3	240 ± 12 degrees	231 ± 17 degrees	224 ± 27
K pulse	11	34 ± 7	245 ± 11	237 ± 16	198 ± 27
P pulse	13	33 ± 3	243 ± 7	236 ± 13	210 ± 18 degrees
V/P pulse	46	32 ± 4	241 ± 13	232 ± 17	226 ± 27
K/P pulse	6	31 ± 4	242 ± 12	230 ± 16	231 ± 24
P/P pulse	11	33 ± 3	241 ± 5	233 ± 12	212 ± 19
Ranjaka (+)	76	31 ± 4	242 ± 11	233 ± 15	216 ± 29
Ranjaka (-)	26	33 ± 4	239 ± 16	233 ± 18	220 ± 25
Prana (+)	41	32 ± 4	240 ± 14	232 ± 18	218 ± 30
Prana (-)	61	32 ± 4	243 ± 12	234 ± 14	215 ± 28
Vyana (+)	47	32 ± 3	244 ± 11	234 ± 16	218 ± 27
Vyana (-)	55	31 ± 4	240 ± 13	232 ± 16	215 ± 29
R (+), V (+)	38	32 ± 3	244 ± 11	234 ± 16	221 ± 26
R (-), V (-)	17	33 ± 4	239 ± 17	231 ± 19	227 ± 22
R (-), V (+)	9	33 ± 3	240 ± 12	240 ± 15	203 ± 24
R (+), V (-)	38	31 ± 4	240 ± 12	232 ± 15	209 ± 31
Rakta Dhatu	52	32 ± 3	242 ± 11	234 ± 16	213 ± 24
Asthi D.	7	32 ± 2	231 ± 7	220 ± 12	232 ± 28
Rasa D.	6	31 ± 2	249 ± 21	238 ± 16	184 ± 19

0.005 (K pulse – 7rd harm.)

0.025 (R (-), V (-) – R (-), V (+))

0.01 (Rakta Dhatu – Asthi D., 4st harm.)

0.03 (Rakta Dhatu – Asthi D., 5nd harm.)

0.06 (Asthi D. – Rasa D., 5nd harm.)

0.0001 (Rakta Dhatu – Rasa D., 7rd harm.)

0.01 (Asthi D. – Rasa D., 7rd harm.)

Table – 3.3

Table 3.3 - The characteristic features of the typical pulse of the superficial pulse and superficial pulse and superf./deep pulse, subdosa and Dhatu pulses.

Items examined : Phase of each constituent harmonized waves obtained from the Fourier analysis of the original radial pulse pressure waves.

	N.	Age	Phase of 8st harm,	Phase $1^{st} - 3^{rd}$ Ang.
V pulse	50	32 ± 3	249 ± 29 degrees	72 ± 23 degrees
K pulse	11	34 ± 7	236 ± 26	57 ± 31
P pulse	13	33 ± 3	239 ± 2	68 ± 13
V/P pulse	46	32 ± 4	249 ± 29	73 ± 18
K/P pulse	6	31 ± 4	254 ± 21	72 ± 16
P/P pulse	11	33 ± 3	243 ± 20	70 ± 13
Ranjaka (+)	76	31 ± 4	242 ± 30	69 ± 20
Ranjaka (-)	26	33 ± 4	253 ± 24	69 ± 27
Prana (+)	41	32 ± 4	247 ± 24	72 ± 24
Prana (-)	61	32 ± 4	243 ± 32	67 ± 20
Vyana (+)	47	32 ± 3	243 ± 24	66 ± 26
Vyana (-)	55	31 ± 4	246 ± 32	72 ± 17
R (+), V (+)	38	32 ± 3	243 ± 22	68 ± 22
R (-), V (-)	17	33 ± 4	255 ± 22	75 ± 17
R (-), V (+)	9	33 ± 3	246 ± 27	58 ± 38
R (+), V (-)	38	31 ± 4	241 ± 36	71 ± 17
Rakta Dhatu	52	32 ± 3	243 ± 28	68 ± 25
Asthi D.	7	32 ± 2	259 ± 16	82 ± 10
Rasa D.	6	31 ± 2	199 ± 41	54 ± 18

0.03 (Welch)

0.0005

0.03

0.02

0.01

Discussion & Conclusions

We have reported that various kinds of analysis of the typical pulse of Tridosa showed that each Dosa pulse had the characteristic features[9] that is K pulse had elongated fatty pulse wave contour which is opposite to the slime V one; on the other hand, P pulse had the vibratory contour. As the basic principles of Ayurveda, K pulse or K/P pulse had the largest L value (Inductance), inertia resistance. These results are compatible with Tridosa theory and they indicate that the characteristic circulatory conditions exist for each Dosa pulse.

This report added the characteristic features of Tridosa pulses diagnosed by Nadi Vijnana by analyzing radial pulse waves according to the Fourier analysis and 1st differentiation.

The results showed significant difference between typical Tridosa pulse, which indicate the possibility to calculate the Dosa balance and the conditions of Subodosa, Dhatu of our body by analyzing the radial pulse waves with the machine.

All these results support the usefulness of Nadi Vijnana for the diagnosis of disease and health according to the Ayurveda Tridosa theory, and the possibility to calculate the Dosa balance and the conditions of Subodosa, Dhatu of the body with the analysis of radial pulse waves by machine was suspected. It is worth trying to research for the unification Ayurveda with the modern medicine via the Nadi Vijnana.

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