

Sa-Am* Acupuncture with Spleen *Seung-gyuck* induces an acute increase of radial pulse parameters related to arterial stiffness in healthy subjects: A comparative study of *Jung-gyuck* and *Seung-gyuck

Yun-Kyoung Yim

Department of Meridian and Acupoint, College of Korean Medicine, Daejeon University, Daejeon, South Korea

Objectives: To investigate the different effects of *Sa-Am* acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* on the radial pulse in healthy subjects.

Methods: Sixty healthy volunteers (30 males and 30 females) participated in this study. The participants were randomly divided into three groups: control (C), *Sa-Am* acupuncture with Spleen *Jung-gyuck* (SP+) and *Sa-Am* acupuncture with Spleen *Seung-gyuck* (SP-). The radial pulse was measured using a multi-step tonometry system before, and 0, 30 and 60 minutes after acupuncture.

Results: The heart rate adjusted radial augmentation index (RAI/HR) and high-tensioned pulse area (W area) significantly increased in the SP- group compared to the C and SP+ groups in males. The systolic pulse period (T4) increased significantly in the SP- group compared to the C and SP+ groups in females. The RAI/HR had positive correlations with W area and T4.

Conclusion: The effects of *Sa-Am* acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* are different. *Sa-Am* acupuncture with Spleen *Seung-gyuck* induces acute increases of radial pulse parameters related to arterial stiffness in healthy subjects.

Key Words : *Sa-Am* Acupuncture, Korean four-needle technique, Spleen *Jung-gyuck*, Spleen *Seung-gyuck*, radial pulse, arterial stiffness.

Introduction

On the basis of traditional East Asian medicine, the pulse implies the physiological and pathological conditions of not only the cardiovascular system, but also the entire human body. An extrinsic stimulus such as acupuncture may affect the body's condition, and subsequently the pulse^{1,2)}. Many studies have reported the effects of acupuncture on the pulse³⁻⁶⁾.

Sa-Am acupuncture is a unique Korean-style

traditional acupuncture which is also called 'five phase acupuncture' or the 'Korean four-needle technique'. It is applied on the basis of the five phase theory to regulate and harmonize the twelve regular meridians and their internal organs by supplementing what is deficient or draining what is excessive⁷⁾.

According to *Sa-Am* acupuncture theory, the supplementing acupuncture activates, tonifies and reinforces the functions of the concerned meridians

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• Correspondence to : Yun-Kyoung Yim

Department of Meridian and Acupoint, College of Korean Medicine, Daejeon University, 96-3, Yongun-dong, Dong-gu, Daejeon 300-716, South Korea

Tel : +82-42-280-2610, Fax : +82-42-280-2641, Email : docwindy@dju.kr

Table 1. Characteristics of Subjects

		Control (n = 20)	Acupuncture		P value*
			SP+ (n = 20)	SP- (n = 20)	
Male (n = 10)	Age (years)	22.00±2.49	20.60±1.07	21.00±1.49	.358
	Height (cm)	174.64±2.58	176.40±2.80	173.70±7.24	.416
	Weight (kg)	71.64±8.18	67.90±6.52	68.30±8.62	.457
	BMI	23.46±2.51	21.85±2.56	22.56±1.54	.206
Female (n = 10)	Age (years)	21.90±1.52	21.50±2.68	20.60±0.84	.171
	Height (cm)	168.60±7.46	166.50±7.68	165.50±6.60	.777
	Weight (kg)	65.60±8.45	62.00±7.67	63.40±6.55	.381
	BMI	23.13±3.27	22.37±2.41	23.15±1.96	.575

Values are mean±SD. SP+: *Sa-Am* acupuncture with Spleen *Jung-gyuck*, SP-: *Sa-Am* acupuncture with Spleen *Seung-gyuck*, BMI: body mass index. *: analysed by Kruskal-Wallis test

and their internal organs, whereas the draining acupuncture deactivates, sedates and reduces them. *Sa-Am* acupuncture with the supplementing prescription is called '*Jung-gyuck*', while *Sa-Am* acupuncture with the draining prescription is called '*Seung-gyuck*'⁷⁾.

The common properties of *Jung-gyuck* and *Seung-gyuck* are that both acupuncture techniques regulate and harmonize the meridians and internal organs on the basis of the five phase theory; at the same time, they differ in the respect that their actions are in opposition⁷⁾. In the present study, I investigated the different effects of *Jung-gyuck* and *Seung-gyuck* of *Sa-Am* acupuncture on the radial pulse in healthy human subjects.

Sa-Am acupuncture can be used for regulation of the twelve regular meridians and their internal organs. In this study, I chose *Sa-Am* acupuncture for the Spleen and its meridian to compare the effects of *Jung-gyuck* and *Seung-gyuck*.

The 'Spleen' is the traditional medical term for an internal organ which governs transportation and transformation, controls blood, and dominates the muscles and limbs (different from the western medical term 'spleen'). The Spleen meridian starts from the tip of the big toe, enters the Spleen and reaches the root of the tongue. Weakness of Spleen *qi* induces inability of the Spleen to control blood, and causes blood leaks from vessels^{1,7)}.

Methods

1. Subjects

Sixty healthy volunteers (30 male and 30 female) with no underlying diseases or prescribed medicines were randomly divided into three groups: a control group (C), a *Sa-Am* acupuncture group with Spleen *Jung-gyuck* (SP+), and a *Sa-Am* acupuncture group with Spleen *Seung-gyuck* (SP-). Each group was comprised of 10 males and 10 females.

The criteria for exclusion were as follows: arrhythmia, systolic blood pressure > 150, diastolic blood pressure < 60, wounds or scars in the region of pulse measurement, body mass index (BMI) < 18 kg/m² or BMI > 32 kg/m², pregnancy, women in menstruation.

All subjects provided written informed consent. This study was approved by the institutional review board of Daejeon University Hospital (approval no. P2011-09-03).

2. Experimental Procedure

The experimental procedure is presented in Figure 1. All volunteers took 30 minutes of rest sitting on a comfortable chair before the experiment. The radial pulse was measured in a sitting position (Figure 2). After the first measurement of the radial pulse, the participants in the acupuncture groups (SP+ and SP-)

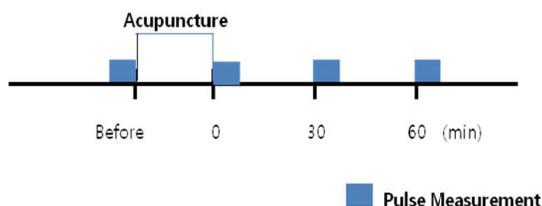


Fig. 1. Experimental procedure



Fig. 2. Pulse Measurement

were given acupuncture in the supine position for 30 minutes, and the participants in the control group (C) took 30 minutes of bed rest. After acupuncture or bed rest, the radial pulse was measured again in the same manner as the first measurement, taking three measurements with 30-minute intervals. The participants were asked to remain calm throughout the experiment. Participants were allowed water, but were restricted from consuming food or other drinks. The experimental room was kept at a stable temperature (24.26 °C) and humidity (40.60%).

3. Acupuncture

Acupuncture was performed by one Korean Medical Doctor (KMD) using disposable needles (0.25 × 30 mm, Dong Bang Acupuncture Co., Korea). The acupoints used in the acupuncture groups are presented in Table 2⁷⁾. All points were used bilaterally. Reinforcing manipulation was done by inserting the needles obliquely following the meridian flow, and rotating the needles clockwise. In contrast, reducing manipulation was done by inserting the needles obliquely against the meridian flow, and rotating the needles counterclockwise⁸⁾. The total acupuncture procedure including insertion, manipulation, retention and withdrawal of the needles took 30 minutes.

4. Pulse Measurement and Data Acquisition

The radial pulse was measured at six different positions (bilateral *Chon*, *Gwan* and *Cheock*) on the wrist. For reliable data acquisition and experimental reproducibility, the position of *Gwan* was marked on the skin in the first measurement. The next measurements were conducted based on this mark, thus guaranteeing that the pulse was measured at the same position in every measurement^{9,10)}.

The pulse was measured using a multi-step tonometry system (Daeyomedi Co. Ltd., Korea). This device has an arterial tonometry sensor with an array of five piezoresistive semiconductor transducers applying multiple levels of pressure to obtain stable multiple-step pulse waveforms¹¹⁾.

In this study, the pressure was applied at five different levels (50 g, 90 g, 140 g, 190 g and 240 g), and the pulse waves were recorded for five seconds

Table 2. Acupuncture Points and Manipulations

	Reinforcing manipulation	Reducing manipulation
<i>Spleen Jung-gyuck</i>	HT8	LR1
	SP2	SP1
<i>Spleen Seung-gyuck</i>	LR1	LU8
	SP1	SP5

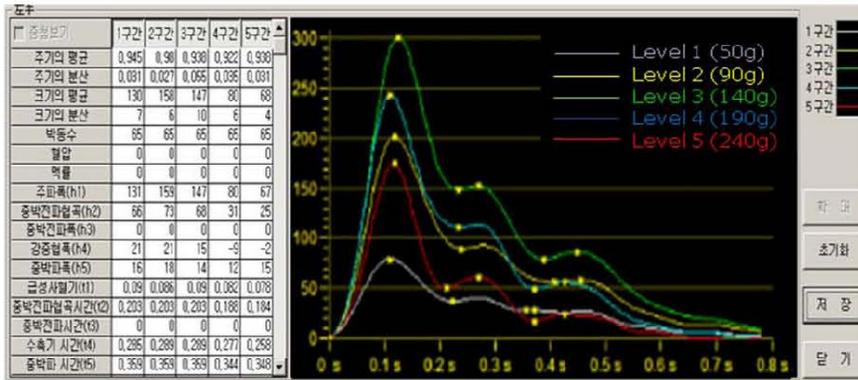


Fig. 3. Pulse waveforms measured at 5 different pressure levels

at each level. The data at each level included five pulse waves from five piezoresistive semiconductor transducers. Therefore, 25 pulse waves were obtained from one measuring position^{9,10}(Figure 3).

5. Data Analysis

1) Pulse wave selection

Among the five different pulse waves obtained at five different levels of applied pressure, the pulse waveform with the highest H1 was the most distinct and suitable to observe the pulse characteristics;

therefore, it was selected as the 'representative pulse wave'(Figures 3 and 4).

The array sensor has five (medial, lateral, distal, proximal, and central) transducers. Among the five transducers, the central transducer is placed above the centre of arterial flow. Therefore, the representative pulse wave from the central transducer was analysed in this study.

2) Pulse parameters (Figure 4)

(1) H1 (div): Amplitude of main peak.

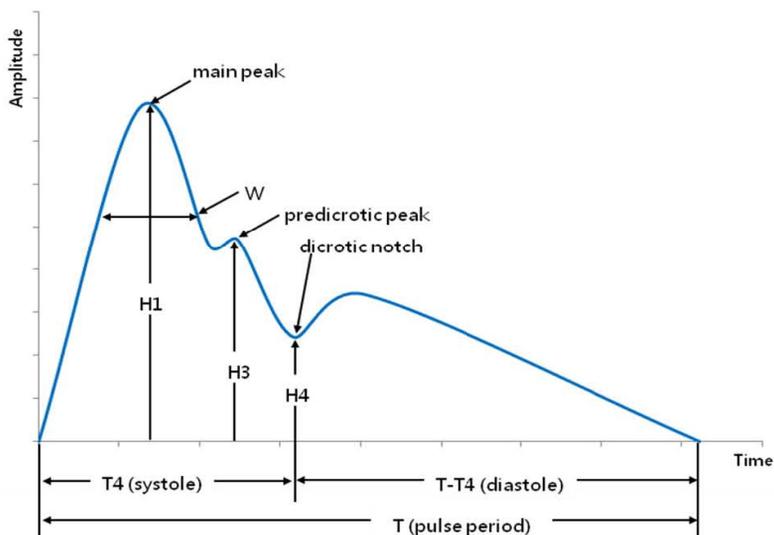


Fig. 4. Radial pulse waveform

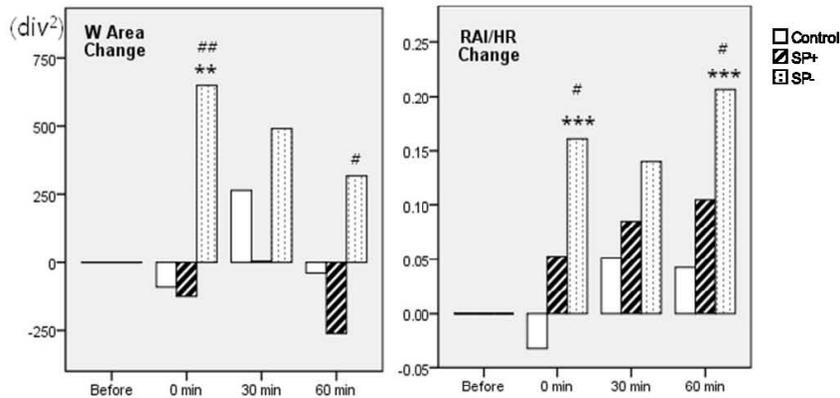


Fig. 5. Changes of pulse parameters by Sa-Am Acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* in Males

SP+: Sa-Am acupuncture with Spleen *Jung-gyuck*,
 SP-: Sa-Am acupuncture with Spleen *Seung-gyuck*,
 ***: p<0.001, **: p<0.01, *: p<0.05, vs control by one way ANOVA,
 ##: p<0.01, #: p<0.05 vs SP+ by one way ANOVA

- (2) H3 (div): Amplitude of predicrotic peak.
- (3) RAI (%): Radial augmentation index; H3/H1
- (4) RAI/HR: Heart rate adjusted radial augmentation index.
- (5) W (sec): High-tensioned pulse period; width of main peak where the pulse height is 2/3 of H1.
- (6) W area (div²): High-tensioned pulse area: area of upper 1/3 of main peak, formed with pulse wave

- and w.
- (7) T4 (sec): Systolic pulse period.

3) Statistical analysis

The statistical analysis was performed using PASW Statistics 18.0. The subjects' general characteristics (age, height and weight) are presented as mean SD (standard deviations). Pulse data are

Table 3. Effects of Sa-Am Acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* on the Radial Pulse in Males

		Measured Value at Each Time Point				P value (time)	P value (group)
		Change from Baseline					
		Baseline	0 min	30 min	60 min		
W Area	C	4582.32±211.33	4491.85±225.19	4953.56±249.87	4543.05±240.56	NS	NS
			▼-90.47±156.89	△264.49±183.11	▼-39.27±153.29		
	SP+	4451.50±196.50	4327.80±252.23	4474.41±241.70	4174.53±254.00	NS	.023
			▼-124.58±225.06	△3.81±192.89	▼-261.05±215.54		
	SP-	4081.02±198.85	4724.64±226.91	4571.32±250.38	4396.16±248.64	.011	.007
			△649.24±188.93	△490.30±270.56	△316.91±214.75		
RAI/HR	C	0.80±0.04	0.77±0.03	0.84±0.03	0.84±0.03	.022	NS
			▼-0.03±0.03	△0.05±0.03	△0.04±0.03		
	SP+	0.78±0.03	0.84±0.03	0.87±0.03	0.89±0.03	.012	.000
			△0.05±0.03	△0.09±0.03	△0.10±0.03		
	SP-	0.87±0.04	1.03±0.04	1.01±0.03	1.03±0.04	.000	.002
			△0.16±0.04	△0.14±0.04	△0.21±0.03		

Values are mean±SE. Parameters were analysed by repeated measures ANOVA (n = 60). △: increase, ▼:decrease. C: Control, SP+: Sa-Am acupuncture with Spleen *Jung-gyuck*, SP-: Sa-Am acupuncture with Spleen *Seung-gyuck*, NS: not significant.

presented as mean ± SE (standard error). The changes of pulse parameters were analysed using repeated measures of analysis of variance (ANOVA). Inter-group comparisons at each time point were analysed using one-way ANOVA and least significant difference (LSD) tests to provide a post-hoc multiple comparison. No significant differences in the changes of pulse parameters were observed between the measuring positions, while significant differences in the changes of pulse parameters between males and females were observed. Therefore, the data obtained from all measuring positions were analysed together; and the data obtained from males and females were analysed separately (n = 60). Pearson correlation coefficients were used to determine the relationships between the pulse parameters. P values of less than 0.05 were considered statistically significant.

Results

1. Pulse Changes in Males

The W area changed significantly in the SP-group compared to the C and SP+ groups (Table 3). The increase of the W area was significantly larger in the SP- group compared to the C group at 0 minutes, and compared to the SP+ group at 0 and 60 minutes (Figure 5).

The RAI/HR changed significantly in the SP-group compared to the C and SP+ groups (Table 3).

The increase of the RAI/HR was significantly larger in the SP- group compared to the C and SP+ groups at 0 and 60 minutes (Figure 5).

The RAI/HR was positively correlated with the W area (r = 0.366, p = 0.000).

2. Pulse Changes in Females

The systolic pulse period (T4) changed significantly in the SP- group compared to the C and SP+ groups (Table 4). The increase of T4 was significantly larger in the SP- group compared to the C group at 0, 30 and 60 minutes, and compared to the SP+ group at 30 and 60 minutes (Figure 6).

The T4 was positively correlated with the RAI/HR (r = 0.344, p = 0.000) and W area (r = 0.409, p = 0.000).

Discussion

The radial augmentation index (RAI) is widely used to estimate arterial stiffness¹²⁾. Considering that the heart rate affects the augmentation index, the RAI is often substituted with the heart rate adjusted radial augmentation index (RAI/HR)¹²⁻¹⁴⁾. In the present study, the RAI/HR significantly increased in the SP- group compared to the C and SP+ groups in males.

The high-tensioned pulse area (W area) also

Table 4. Effects of *Sa-Am* Acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* on the Radial Pulse in Females

	Measured Value at Each Time Point				P value (time)	P value (group)
	Change from Baseline					
	Baseline	0 min	30 min	60 min		
C	0.33±0.003	0.32±0.002 ▼-0.003±0.003	0.32±0.003 ▼-0.004±0.003	0.32±0.002 ▼-0.002±0.003	NS	NS (C vs SP+)
T4	0.32±0.003	0.32±0.004 △0.002±0.004	0.32±0.003 ▼-0.002±0.003	0.32±0.002 △0.001±0.003	NS	.001 (C vs SP-)
SP-	0.32±0.003	0.33±0.003 △0.008±0.002	0.34±0.003 △0.010±0.003	0.34±0.004 △0.011±0.004	.008	.014 (SP+ vs SP-)

Values are mean ± SE. Parameters were analysed by repeated measures ANOVA (n = 60). △: increase, ▼: decrease. C: Control, SP+: *Sa-Am* acupuncture with Spleen *Jung-gyuck*, SP-: *Sa-Am* acupuncture with Spleen *Seung-gyuck*, NS: not significant.

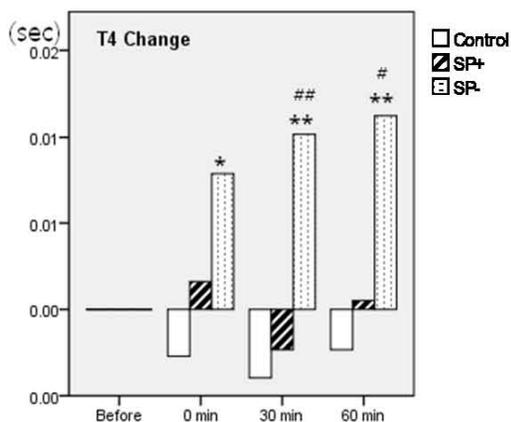


Fig. 6. Change of T4 by *Sa-Am* Acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* in Females

SP+: *Sa-Am* acupuncture with Spleen *Jung-gyuck*,
 SP-: *Sa-Am* acupuncture with Spleen *Seung-gyuck*,
 **: $p < 0.01$, *: $p < 0.05$, vs control by one way ANOVA
 ##: $p < 0.01$, #: $p < 0.05$ vs SP+ by one way ANOVA

increased in the SP- group compared to the other groups in males. Lee et al.[15] suggested the W area as a new parameter for estimating arterial stiffness according to aging and arteriosclerosis. In our study, the correlation analysis showed that the RAI/HR was positively correlated with the W area ($r = 0.366$, $p = 0.000$).

These results may be interpreted that *Sa-Am* acupuncture with Spleen *Seung-gyuck* induced acute increases of arterial stiffness and tension compared to bed rest and *Sa-Am* acupuncture with Spleen *Jung-gyuck* in the physiological condition in males.

The existence of gender differences in the radial pulse has been recognised^{1,16}. The physiological responses of the radial pulse to acupuncture may also be different between males and females.

In the present study, females showed no significant changes in the RAI/HR and W area. However, the systolic pulse period (T4) increased significantly in the SP- group compared to the C and SP+ groups in females. Increased arterial stiffness causes an early return of the reflected wave from the peripheral reflecting sites to the heart during systole, and

subsequently increases systolic duration⁸). In this study, the correlation analysis showed that T4 was positively correlated with the RAI/HR ($r=0.344$, $p=0.000$) and W area ($r=0.409$, $p=0.000$). Therefore, I presume that the increase of systolic pulse period in the SP- group may also be related to the increase of arterial stiffness.

In summary, the effects of acupuncture may differ by gender; in this study, significant changes were observed after *Sa-Am* acupuncture with Spleen *Seung-gyuck* in different pulse parameters according to gender. In addition, acupuncture may have common effects in both males and females; in this study, *Sa-Am* acupuncture with Spleen *Seung-gyuck* increased the pulse parameters related with arterial stiffness in both males and females.

There have been reports of the association of arterial stiffness with haemorrhage.¹⁷⁻¹⁹ I speculate that the blood leaks from Spleen *qi* deficiency in traditional East Asian medical theory correspond with the haemorrhage from high arterial stiffness in modern studies.

According to the theory of *Sa-Am* acupuncture,

Jung-gyuck and *Seung-gyuck* possess opposite actions. Spleen *Jung-gyuck* activates, tonifies, and reinforces the functions of the Spleen and its meridian, while Spleen *Seung-gyuck* deactivates, sedates, and reduces them.

In the present study, *Sa-Am* acupuncture with Spleen *Jung-gyuck* did not induce significant changes on the radial pulse compared to the control (C) group; however, *Sa-Am* acupuncture with Spleen *Seung-gyuck* induced significant increases in the pulse parameters related with arterial stiffness.

I assume that the increases of the pulse parameters related with arterial stiffness in the SP- group may be associated with the decrease of the Spleen function to control blood and prevent bleeding. Since Spleen *Jung-gyuck* did not induce significant pulse changes in the present study, whether *Sa-Am* acupuncture with Spleen *Jung-gyuck* reduces arterial stiffness cannot be answered at this time. However, I believe that acupuncture stimulus may affect the human body more significantly when it is needed (in the pathological condition) than when it is not needed (in the physiological condition). This study was performed on healthy subjects in the physiological condition; therefore, I expect that further studies on patients with high arterial stiffness may reveal more on this issue.

What is important in life is regulation to maintain the physiological range, not to reduce arterial stiffness. Fixed patterns of thinking (e.g., hypertension is bad, hypotension is good; high arterial stiffness is bad, low arterial stiffness is good; meat diet is bad, vegetarian diet is good, etc.) are unreasonable and should be avoided. *Jung-gyuck* and *Seung-gyuck* are two ways of regulation. It is not a matter of which is bad or which is good. Either will be good when it is needed for the patient (appropriate treatment), while either will be bad when the opposite is needed (inappropriate treatment).

In this study, I suggested an objective method to investigate the different effects of different acupuncture

techniques with different actions. This may be a new approach to investigate the mechanisms of acupuncture as well as the relationship between East Asian medical theory and modern physiopathology.

Conclusion

The effects of *Sa-Am* acupuncture with Spleen *Jung-gyuck* and Spleen *Seung-gyuck* are different. *Sa-Am* acupuncture with Spleen *Seung-gyuck* induces acute increases of radial pulse parameters related to arterial stiffness in healthy subjects.

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