The Influence of Cardiovascular system caused by warming effect of Far-infrared radiation

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Abstract: As a result of using a heat generator to experiment the physiological influence of the human body due to the warming effect of far-infrared radiation (FIR), the blood pressure of the subjects lowered and stabilized due the expansion of capillary vessels and salt discharge during perspiration as the temperature of the generator elevated(30~65℃). In case of heart rate, it decreased and stabilized when the temperature of the 'far-infrared radiation heat generator' was at a low temperature below 40℃. At a high temperature above 44℃, there was a slow elevation in the heart rate. However, the elevation of the heart rate is not a sudden elevation, therefore, does not give much stress to the heart.

Keywords: far-infrared radiation, warming effect, blood pressure, heart rate

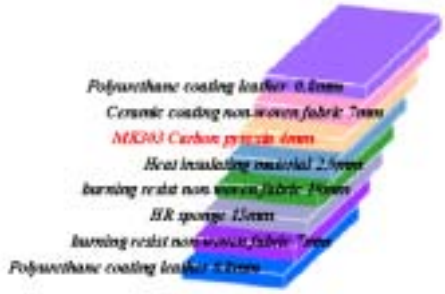
1. INTRODUCTION

Application of the far-infrared radiation (FIR) to the body will raise the temperature in the whole body hyperthermia, expand capillary vessels and increase blood circulation, elevated organism's reproduction and soothes aches and pains, increases relaxation, speeds up healing and induces sweating. Its research details are being reported, and it is used as a natural treatment in the Northeast to treat chronic illnesses[1,2,3,4]. As a result, in this experiment, a study of physiological influence of the human body due to the warming effect of FIR made by measuring body's parameter such as the blood pressure.

2. MATERIALS

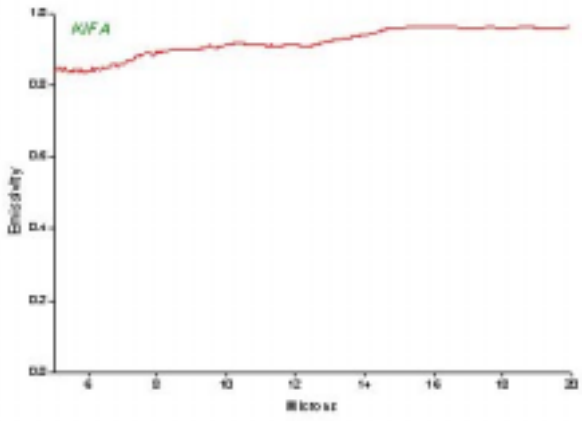
Far-infrared radiation (FIR) heat generator was made to expose human body to far-infrared rays, for which mattress type is available. In this research, FIR heat generator was developed in collaboration with Naegabomeditec Co. Ltd., Seoul, Korea. Figure 1 show FIR heat generator's (a)external (b)internal. Also, as a result of measuring emissivity and emission power of FIR, using the FT-IR spectrometer an ideal black body radiation similar to a spectroscopic characteristic appeared (Fig. 2).

(a) external

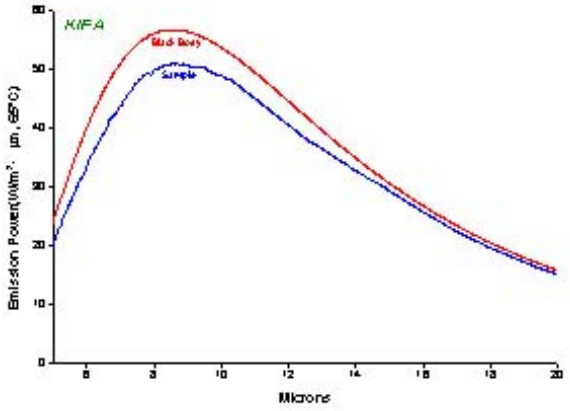


(b) internal

Fig.1 FIR heat generator



(a) emissivity



(b) emission power

Fig. 2 Spectroscopic characteristic of FIR heat generator at 65℃

3. METHODS

Subject were laid down on a bed for 5~10 minutes to stabilize the physiological rhythm. For 30 minute, with 5 minute intervals, measurement of the blood pressure and heart rate were made without giving the warming effect of FIR(control). After, subjects were laid on the FIR heat generator, measurement of the previously mentioned body ' s parameters were made using a similar method applying the warming effect of FIR at temperatures from 30~65℃ for 30 minutes.

Fig. 3 Measurement of the physiological parameters

4. RESULTS

Decrease and stabilization of the blood pressure seems to be effected by the warming effect of FIR, which influenced the expansion of capillary vessels and salt secretion during perspiration. Therefore, warming effect of the FIR will elevate the body's temperature thus causing perspiration. During perspiration, sweat and Na ion that is contained in the blood will exit the body. At this time, the volume of H_2O, which allows for the combining of the Na+(sodium ion) in the blood, will also decrease. As a result, blood pressure will drop due to the decreased volume of water, which lowers the amount of pressure affected on the capillary vessel.

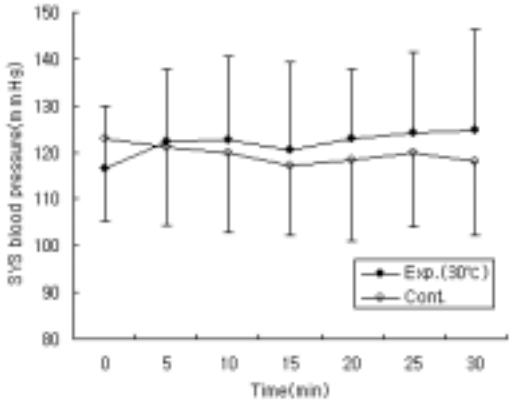
4.1 Systolic blood pressure

Average change in systolic blood pressure decrease 14.3% (65℃) at max, and decreases average of 3.4 ~ 8.5% at 44 ~ 65℃

Table 1 Data table for systolic blood pressure

Time(min)	Cont.	Exp.(30 ℃)	Exp.(35 ℃)
0	122.8 ± 17.5	116.5 ± 13.4	105 ± 12.2
5	121.1 ± 16.8	122.3 ± 15.6	124.3 ± 16.5
10	120 ± 17.1	122.6 ± 17.9	125.1 ± 18.6
15	117.3 ± 15.1	120.4 ± 18.9	124.3 ± 18.5
20	118.3 ± 17.5	123 ± 14.7	128.3 ± 18.5
25	119.9 ± 16.0	124 ± 17.3	124.5 ± 18.3
30	118 ± 15.7	124.8 ± 21.5	125.8 ± 15.4
Time(min)	**Exp.(40 ℃)**	**Exp.(44 ℃)**	**Exp.(48 ℃)**
0	115.6 ± 13.4	*112.2 ± 15.8	121.1 ± 8.9
5	112.4 ± 11.3	*109.8 ± 14.0	115.3 ± 12.2
10	115.2 ± 13.3	*108.6 ± 13.5	114.1 ± 10.5
15	112.8 ± 11.3	109.4 ± 14.2	113.5 ± 12.0
20	112.8 ± 11.3	*108.6 ± 13.7	113.0 ± 10.5
25	*110.8 ± 11.9	*108.4 ± 14.2	115 ± 11.2
30	111.6 ± 11.1	*109.8 ± 14.1	112.5 ± 10.8
Time(min)	**Exp.(52 ℃)**	**Exp.(56 ℃)**	**Exp.(65 ℃)**
0	120.5 ± 11.7	120.7 ± 8.6	*111 ± 7.2
5	115.3 ± 14.8	113.6 ± 9.8	*108.4 ± 15.1
10	115 ± 9.5	116 ± 10.6	*109.7 ± 15.8
15	116.0 ± 10.8	114.4 ± 10.5	109.8 ± 15.7
20	116.0 ± 11.6	117.1 ± 11.4	*109.2 ± 14.0
25	115.7 ± 13.1	115.0 ± 10.5	*111.4 ± 13.8
30	115.2 ± 12	115.8 ± 11.3	*109.4 ± 15.0

mean±SEM, * $p < 0.05$, unit : mmHg



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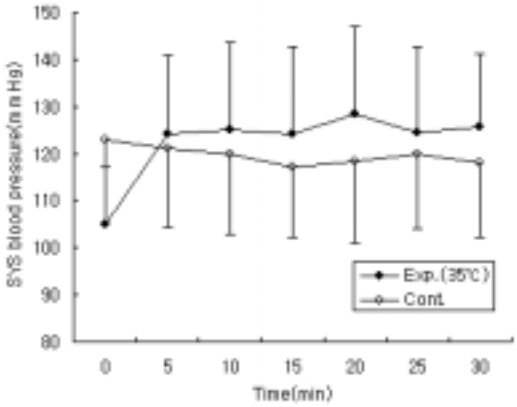

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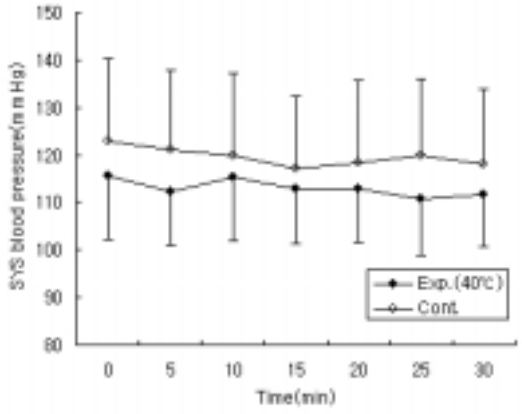

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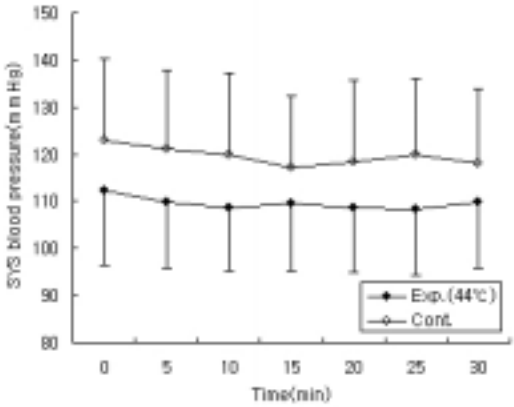

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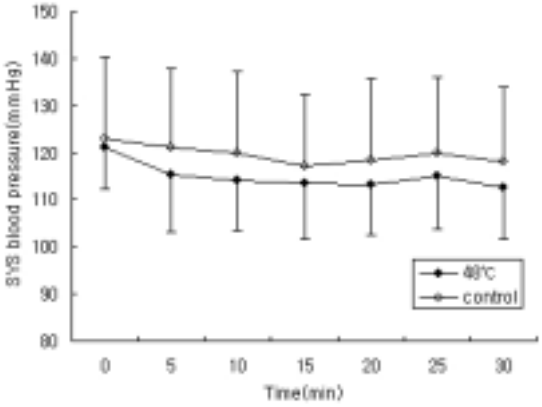

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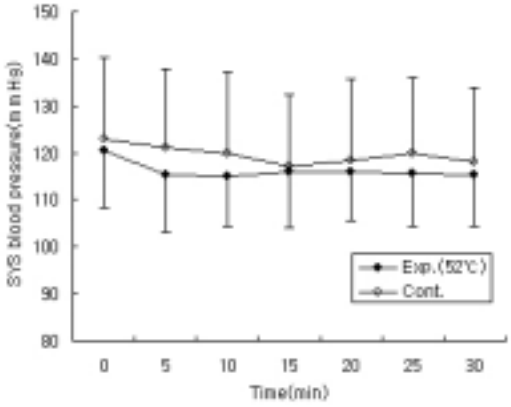

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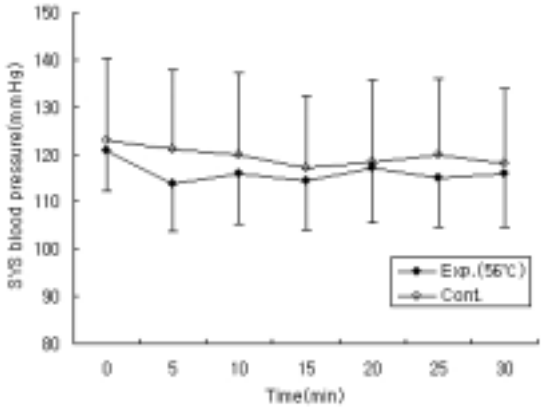

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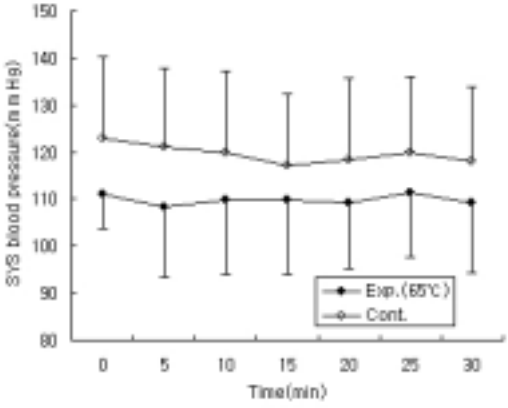


(h)

Fig. 4 Average fluctuation of the systolic blood pressure due to the warming effect of FIR (30~65℃)

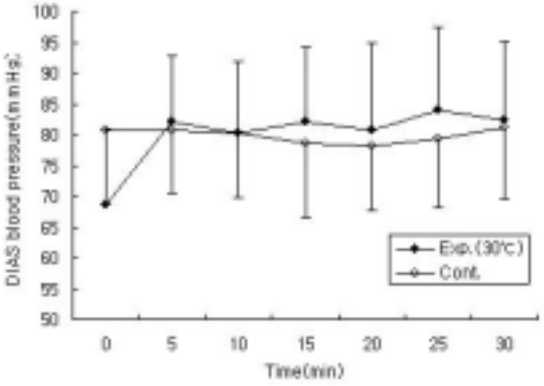
4.2 Diastolic blood pressure

Average change in diastolic blood pressure decreased 12.5% (65℃) at max, and decrease an average of 4.5 ~ 9.6% at 44 ~ 65℃.

Table 2 Data table for diastolic blood pressure

Time(min)	Cont.	Exp.(30℃)	Exp.(35℃)
0	80.8 ± 11.8	*68.5 ± 10.7	76 ± 12.2
5	80.7 ± 10.1	82 ± 12.5	82.4 ± 13.7
10	80.3 ± 10.6	80.3 ± 10.8	80.8 ± 12.5
15	78.7 ± 12.2	82.2 ± 10.5	84.4 ± 14.4
20	78.2 ± 10.4	80.8 ± 13.1	84.9 ± 12.7
25	79.3 ± 11.2	83.9 ± 14.3	86.1 ± 12.7
30	81.1 ± 11.5	82.4 ± 12.8	84.2 ± 11.8
Time(min)	Exp.(40℃)	Exp.(44℃)	Exp.(48℃)
0	79 ± 9.3	77.2 ± 12.4	76.9 ± 5.5
5	*74.1 ± 10.3	*73.9 ± 8.8	*74.6 ± 8.9
10	*73.7 ± 8.9	*72.1 ± 8.1	*74.5 ± 8.2
15	73.9 ± 9.8	73.3 ± 9.7	*70.8 ± 7.5
20	74.1 ± 9.2	*71.8 ± 9.1	*72.0 ± 8.2
25	*71.0 ± 8.2	74.0 ± 11.3	*72.1 ± 8.8
30	74.8 ± 11.1	*73.1 ± 9.3	*73.2 ± 7.8
Time(min)	Exp.(52℃)	Exp.(56℃)	Exp.(65℃)
0	76.7 ± 6.4	76.9 ± 6.4	75.1 ± 5.3
5	*74.2 ± 7.8	*74.2 ± 6.8	*72.4 ± 9.3
10	*74.0 ± 8.2	*74.1 ± 6.4	*71.9 ± 10.7
15	73.1 ± 7.5	74.5 ± 11.7	72.3 ± 13.8
20	73.7 ± 9.2	73.2 ± 7.2	*72.3 ± 9.5
25	74.8 ± 7.2	*71.8 ± 8.4	*72.4 ± 10.1
30	*75 ± 7.5	*74.4 ± 9.0	*70.9 ± 9.8

mean±SEM, * $p < 0.05$, unit : mmHg



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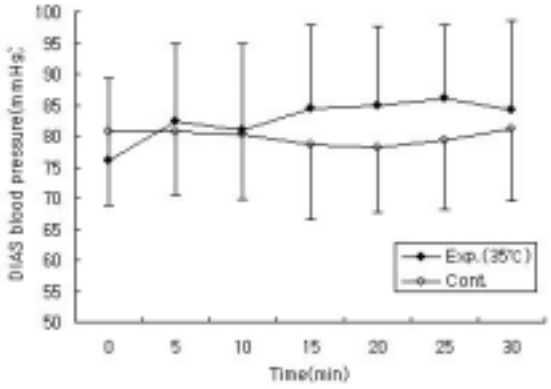

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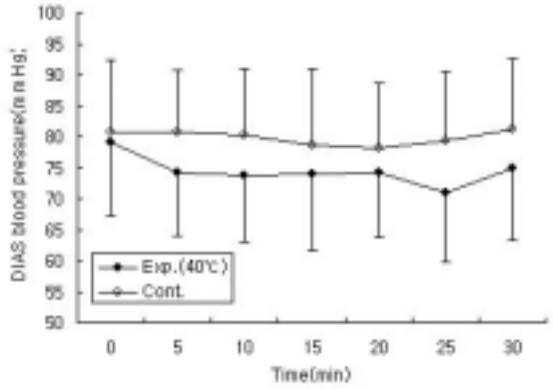

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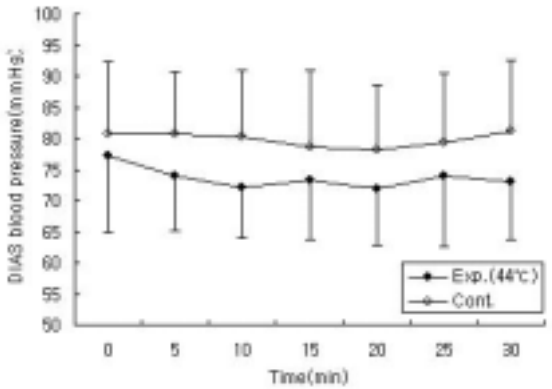

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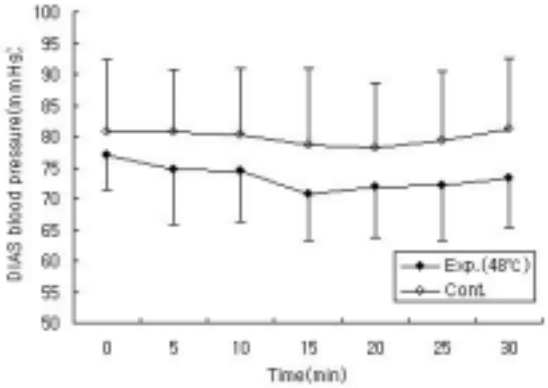

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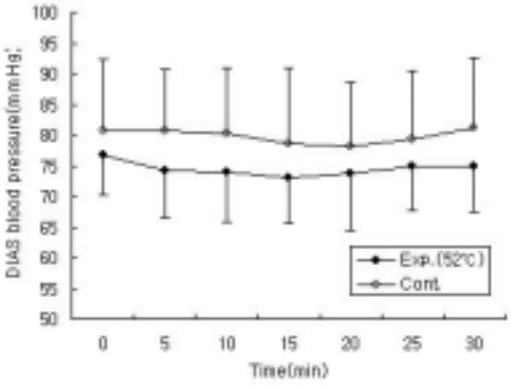

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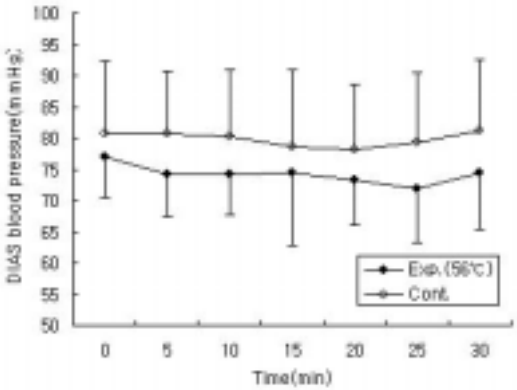

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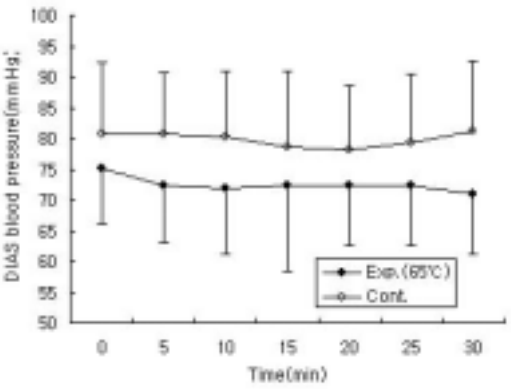

(h)

Fig. 5 Average fluctuation of the diastolic blood pressure due to the warming effect of FIR (30~65℃)

4.3 Heart rate

Table 1 The caption should be placed before the table.

Experiment	mean±SEM
Cont.	67.68±8.62
Exp.(30℃)	64.17±7.95
Exp.(35℃)	64.74±8.47
Exp.(40℃)	68.95±7.22
Exp.(44℃)	69.88±7.92
Exp.(48℃)	71.57±6.88
Exp.(52℃)	*71.96±7.30
Exp.(56℃)	*72.35±7.39
Exp.(65℃)	*73.20±7.54

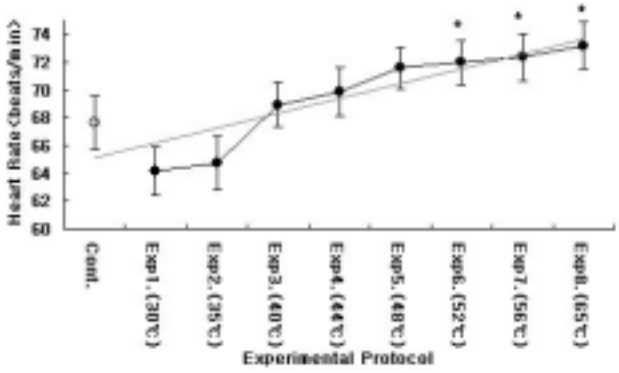

Fig. 6 The average fluctuation of heart rate (*p<0.05)

4. CONCLUSIONS

Results of experimenting physiological influence of the human body due the warming effect of FIR using the far-infrared radiation heat generator are as followed:

1) As a result of measuring the blood pressure change followed by the temperature change due to the warming effect of FIR, it was clear that far-infrared radiation influenced the physiological functions at a standard temperature. When far-infrared radiation heat generator was at a high temperature, blood pressure dropped and stabilized. When the temperature was low, below 44℃, observation was made that the blood pressure dropped due to the capillaries expansion. However, at a high temperature, above 44℃, observation was made that there was a greater decrease in the blood pressure due to joint function of the capillary expansion, and decrease in blood volume and discharge of Na^+(sodium)

2) Stabilization and activeness of the physiological function due to the warming effects of FIR can be confirmed through heart rate and cardiac output. It's noticed that warming effect of FIR doesn't apply much stress to the heart. Heat rate and cardiac output rises as the temperature of the blood elevates.

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