

## Effect of Foot Reflexology on the Vital Signs, Blood Cortisol, Lymphocytes and Natural Killer Cell of Female Cancer Patients

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### 국문초록

#### 발반사마사지가 여성암환자의 활력징후, 코티졸, 면역반응에 미치는 효과

목적 : 이 연구는 항암제를 투여받는 여성암환자에서 발반사마사지가 스트레스반응(활력징후, 코티졸)과 면역반응에 미치는 효과를 평가하기 위함이다.

방법 : 11명의 여성암 환자를 임의로 표출한 후 단일군 전후실험설계로 진행하였다. 종속변수는 스트레스 반응으로 활력징후(수축기 혈압, 이완기 혈압, 맥박수, 호흡수)와 혈중 코티졸, 면역반응으로 림프구 아군(CD3, CD4, CD8, CD19)과 자연살세포(NK cells)이며, 독립변수는 발반사마사지이었다. 중재 전후 종속변수의 변화를 보기 위해 Wilcoxon signed rank test를 실시하였다.

결과 : 중재 전에 비해 중재 후 수축기 혈압, 이완기 혈압, 맥박수, 혈중 코티졸치, CD4와 CD19는 유의한 변화를 보였으나 호흡수, CD3, CD8, 그리고 자연살세포는 유의한 변화를 보이지 않았다.

결론 : 이러한 연구결과는 발반사마사지가 항암화학요법을 받는 여성암 환자의 스트레스 호르몬과 면역관련세포에 영향을 보였지만 표본수가 작고 중재가 1회에 그쳤기 때문에 이러한 단점을 보완한 추후연구를 통해 발반사마사지의 효과를 좀더 잘 규명할 수 있을 것이다.

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**Key words** : Reflexology, Stress, Immunity

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## Introduction

The incidence of cancer has been steadily increasing and has now become the leading cause of death in South Korea (Korea National Statistical Office, 2001). Most cancer patients experience varying level of stress related to fear of death, anxiety about recurrence, negative experiences related to the treatment process, economical burden, vocational difficulties, and social isolation (Derogatis & Melisaratos, 1979 ; Derogatis et al, 1983). Stress stimulates the adrenal gland of the human body to produce blood corticosteroids and catecholamines (Lindsay & Carrieri, 1986), which suppress the immune functions of T lymphocyte and Natural Killer (NK) cells (Robinson, 1990). This weakens patients' resistance to other diseases. Psychoneuroimmunologic findings have demonstrated a relationship between stress and cancer, suggesting that acute/chronic stress destroys immune function, thus contributing to increased morbidity of cancer (Kiecolt-Glaser, Cacioppo, Malarke, Glaser, 1992).

According to the Bennet(1997), the mirthful laughter significantly correlated with change in the NK cytotoxicity. But, the nursing interventions designed to decrease the level of stress have been limited. Massage on the back or hand, as a traditional nursing skill, has been used for many years to promote circulation and to decrease pain. It is generally accepted that massage is a useful alternative therapy to treat pain and to promote quality of life of

patients with chronic illnesses (Massie & Holland, 1987). The effects of hand and back massages have been tested on reducing pain, fatigue, anxiety, stress hormones production and itching sense, improving the immune function, and stabilizing vital signs(Barr & Taslitz, 1970 ; Cho, 1999 ; Field, Morrow, Valden, Larson, Kuhn, & Schanberg, 1992 ; Kim & Lee, 1998 ; Kim, 2000 ; Lee, 2000 ; Meek, 1993 ; Snyder, Egan, & Burns, 1995). Researchers reported that a back massage could reduce the anxiety and pain of cancer patients(Ferrll-Torry & Glick, 1992 ; Weinrich & Weinrich, 1990), and a hand massage was able to decrease the anxiety of cancer patients undergoing radiation therapy(Park & Suh, 1995). Recently, with growing interests in independent and alternative nursing interventions, various massage techniques are being developed and introduced. Among them, foot reflexology which stimulates the reflex arch of the foot, has been the most popular. It has been reported that foot reflexology is effective for reducing the stress related to nursing students' clinical practices (Won et. al., 2000) and premenstrual syndrome or dysmenorrhea in university students (Baik, 1999 ; Oleson & Flocco, 1993).

According to psychoneuroimmunology, perceived stress is related to the autonomic nervous system, which influences vital signs and serum cortisol (Lindsay & Carrieri, 1986), and cortisol can alter immune functions (Robinson, 1990). Based on that theory, we can make a hypothesis that foot reflexology would lower systolic and diastolic blood pressure, pulse rate, respiration rate, level of

serum cortisol, and the proportion of suppressor cells, and would increase the proportion of T cells, B cells, helper cells, and NK cells of the female cancer patients undergoing chemotherapy. Increased heart rate and blood pressure were seen in the mental arithmetic group, and persons in this group also had increased NK activity and lymphocyte proliferation during the task and 5 minutes after the task ended (Delahanty et al, 1996). Similar results were reported in an earlier study of mental arithmetic stress in women. Younger women had an increase in NK cell activity following a 12 minutes mental arithmetic examination (Naliboff et al, 1991). These results demonstrate that the NK cell can react very quickly to stimuli. Therefore, it is possible that briefly decreasing psychological stress by foot reflexology may be associated with rapid changes in NK activity.

Even though the scientific approach has tried to investigate foot reflexology effects, they have been very limited. Furthermore, there have been no studies done to investigate the effects of foot reflexology in the short term on reducing stress and improving the immune function of cancer patients in a short time. Therefore, this study was aimed to investigate the effects of foot reflexology on reducing stress and enhancing immune function of cancer patients in the short term, and the objectives were to analyze the effect of foot reflexology on the vital signs, serum cortisol level, the number of lymphocyte subset, and NK cells of female cancer patients undergoing chemotherapy.

## Methods

### Research design

The one-group pretest-posttest design was used to test the effect of foot reflexology on the vital signs, cortisol and immune function of female cancer patients undergoing chemotherapy.

### Subjects

The subjects were 11 female cancer patients receiving chemotherapy who were hospitalized in either two of the selected university hospitals in Seoul. Inclusion criteria in this study were 1) diagnosis of cancer, 2) female aged 18 or more, 3) not in the first chemotherapy schedule, 4) have not taken surgery or radiation therapy within 6 months, 5) not having any other systematic disease.

All the participants in the study gave informed consent voluntarily in accordance with the standards of the Institute of Review Board of Seoul National University Hospital.

### Data Collection

Before beginning the study, ethical and scientific approval was obtained from the Institutional Review Board of Seoul National University Hospital. All subjects completed a demographic data questionnaire with their consent. The vital signs of the subjects

were measured, and 5cc of blood was drawn from each subject to test for the baseline level of cortisol, lymphocytes and NK cells. Participants were then given foot reflexology for 30 minutes by a well-trained reflexologist. Vital signs and blood samples were taken again for the post- test no later than 10 minutes after treatment. The level of lymphocytes, and NK cells could be altered by pain related to venipuncture and sampling time (Bennet, 1997). Therefore, all the blood specimens for this study were collected at the same time of day(around 2 PM) and by the same person who had ten-year's experience as a clinical technician and was good at venipuncture. To avoid the possibility of temporary changes in the immune function caused by the chemotherapy itself, all procedures were carried out before chemotherapy started.

### Independent variables (foot reflexology)

Foot reflexology for this study consisted of three steps : preparation stage, relaxation massage, and reflex arc massage. It is similar to a conventional massage, but it includes a step for pressure reflex arcs on the foot, which are matching points for the whole body. In foot reflexology, if reflex arcs on the foot are pressured, it is similar to adding pressure to those body sites (Sudmeier, Bodner, Nur, Ulmer, Herold, 1999). That is to say, if we apply pressure to the foot reflex arcs matched to the adrenal gland or kidney, it is regarded as applying pressure directly to the adrenal gland or kidney. The length of intervention was approximately 30 minutes and the specific procedures are summarized in Table 1.

Table 1. Procedures of foot reflexology

Step 1 : Preparation	Wash the both feet and soak them in warm water for 2 minutes
Step 2 : Relaxation massage	1. Put some lotion on both hands and then with firm steady pressure stroke upward from the base of the toes up to the foot and lower leg to the knee.
	2. Stroke the sole and top of the foot with both hands together.
	3. Stroke lateral sides of the foot.
	4. Make circular movement around the malleus bone.
	5. Give firm pressure on the Achilles tendon and heel.
	6. Stroke from heel to the center of the foot(Yongcheon).
	7. Press firmly the center of the foot(Yongcheon).
Step 3. Reflex arc massag	1. Massage 5 times on the basic reflex points of the left foot(kidney, ureter, bladder, urethra).
	2. Massage 10 times on the direct reflex points(head-central brain, neck, shoulder, trapezius muscle, sciatic nerve, liver).
	3. Massage 5 times on the indirect reflex points(vertebra-from cervical to coccygeal, eye, GI tract-from stomach to anus, diaphragm).
	4. Massage 5 times on the basic reflex points(kidney, ureter, bladder, urethra) again.

## Measures

### 1) Vital signs

Vital signs of all the subjects were measured by a research coordinator. Blood pressure was measured with a mercury sphygmometer, which checked the test-retest reliability. Radial pulse rates and respiration rates were measured for one minute with the subject lying in a supine position.

### 2) Serum cortisol level

The sampling nurse collected 2cc of blood in an SST (yellow top) tube to test the serum cortisol level. The blood samples were immediately taken to the clinical lab at the Seoul National University Hospital for testing. The reference value for serum cortisol level is 5-26 $\mu$ g/ml.

### 3) Lymphocytes

To measure the number and proportion of lymphocyte subsets, such as T lymphocyte (CD3), helper/inducer T cell (CD4), suppressor/cytotoxic T cell (CD 8), and total B lymphocyte (CD19), 3cc of blood was collected in an EDTA tube. The blood samples were taken to the clinical lab at the Seoul National University Hospital, which adhered to the National Committee for Clinical Laboratory Standards (NCCLS) Guidelines of America and is a member of the Association for Korean Laboratory Quality Control. Because many samples for research and diagnoses and have already been tested for many years in this lab, we didn't felt it was not necessary to make a

reliability test only for this study. The reference values of CD3, CD4, CD8, CD19 are 61~85%, 28~58%, 19~48%, and 7~23% respectively; The normal range for these levels are very wide.

### 4) NK Cells

To measure the number and proportion of NK cell, blood samples for the lymphocyte assay were used again. This procedure was also done at the clinical lab of the Seoul National University Hospital. After dyeing the serum with CD16 and CD56 antibodies, the % of NK cells was measured using a flowcytometer (BD Bioscience FACS). The reference value of NK cell ratio in healthy adults is 6~23%.

## Statistical Analysis

With the SPSS for Window (version 8.0) program, the data were analyzed using the Wilcoxon signed rank test, which is a non-parametric statistical test to compare paired orders of two related groups. The .05 significance level was used for determining statistical significance. Though we can generally consider both the number and cytotoxicity in analyzing the lymphocyte subsets and NK cells, this research only assayed the number of lymphocyte subsets and NK cells. Because the number of lymphocytes and NK cells is related to the total number of leukocytes, we used relative proportions (%) to total leukocytes instead of the absolute counts of the cells.

## Effect of foot reflexology on cortisol

### Results

#### Characteristics of subjects

Among eleven (mean aged 52, ranging from 28 to 73), five had ovarian cancer, three had uterine cancer, and three had rectal cancer. The regimen of chemotherapy was either taxol-carboplatin regimen or 5-FU- Leukovorine regimens.

#### Effects of foot reflexology on vital signs

The post-intervention SBP and DBP were significantly lower than those of pre-intervention ( $p=.009$ ,  $p=.014$ , respectively) (Table 2). Pulse rate also decreased significantly after foot reflexology ( $p=.031$ , Table 2). However, there was no significant difference in respiration rate between pre and post interventions ( $p=.250$ , Table 2).

The post-intervention serum cortisol level was significantly lower than that of pre-intervention ( $p=.006$ ). This means that reflexology was effective in decreasing the serum cortisol level of the cancer patients receiving chemotherapy (Table 3).

#### Effects of foot reflexology on lymphocyte subsets

Post-intervention proportions of helper T cells (CD4) and total B lymphocytes (CD 19) decreased significantly as compared to those of pre-intervention ( $p=.008$ ,  $p=.049$ , respectively, Table 4). The change of total T lymphocytes (CD3) and suppressor T lymphocytes (CD8) were not statistically significant ( $p=.211$ ,  $p=.223$ , respectively, Table 4).

Table 2. Comparison of blood pressure between pre and post foot reflexology (n=11)

Variables	Pre_mean	Post_mean	Z-value <sup>a</sup>	P-value
Systolic blood pressure	136.4(20.6)	125.0(12.4)	-2.6	.009
Diastolic blood pressure	81.8(13.3)	75.0(12.0)	-2.5	.014
Pulse rate	80.2( 9.5)	74.9( 8.9)	-10.5	.031
Respiration rate	19.2( 2.7)	17.6( 0.8)	-3.0	.250

a : Wilcoxon signed rank test

Table 3. Comparison of serum cortisol level between pre and post foot reflexology (n=11)

Variable	Pre_mean	Post_mean	Z-value <sup>a</sup>	P-value
Cortisol	11.5(5.4)	8.5(4.2)	-2.8	.006

a : Wilcoxon signed rank test

Table 4. Comparison of lymphocyte subsets between pre and post foot reflexology (n=11)

Variables	Pre_mean	Post_mean	Z-value <sup>a</sup>	P-value
CD 3(%)	63.6(7.7)	64.9(6.8)	9.0	.211
CD 4(%)	33.5(7.8)	35.6(7.4)	25.5	.008
CD 8(%)	28.1(5.9)	29.1(6.5)	12.5	.223
CD19(%)	15.4(6.8)	16.9(6.9)	19.0	.049

a : Wilcoxon signed rank test

### Effect of foot reflexology on NK cells

The NK cell ratio after foot reflexology was not statistically significant(p=.078, Table 5).

## Discussions

Most cancer patients experience varying levels of stress related to fear of death, anxiety about recurrence, negative experiences related to the treatment process, economical burden, vocational difficulties, and social isolation (Derogatis & Melisaratos, 1979 ; Derogatis et al., 1983). This stress may lead to depression in immune function and to raise susceptibility to certain diseases (Kiecolt-Glaser et al, 1992). Therefore, proper nursing intervention needs to be developed to decrease the stress level of cancer patients. The current study is objective was to evaluate the effects of foot reflexology on improving vital signs, emotional response and to identify the

usefulness of it as a nursing intervention for cancer patients.

The findings of this study support the view that foot reflexology has a significant effect on the vital signs and immune function. There were significant differences in systolic blood pressure(SBP), diastolic blood pressure (DBP, and pulse rate (p=.031) between pre and post intervention. The vital signs of the study subjects before foot reflexology were all within normal limits, and the post intervention vital signs were still in the normal range, even though there was a little change in them. These results were consistent with the findings from other studies (Baik, 1999 ; Barr & Taslitz, 1970 ; Ferrell-Torry & Glick, 1992 ; Meek, 1993). This stabilization in vital signs seems to be a general result of relaxation induced by massage. The fact that respiration rate didn't yield a statistically significant difference was related to a relatively small sample size.

Stress stimulates the adrenal gland of the human body to produce blood corticosteroids and catecholamines. Therefore, when a subject is in a stressful situation, his /her

Table 5. Comparison of natural killer cell between pre and post foot reflexology (n=11)

Variable	Pre_mean	Post_mean	Z-value <sup>a</sup>	P-value
Natural killer cell (%)	19.0(7.6)	17.5(7.2)	-11.5	.078

a : Wilcoxon signed rank test

cortisol level in the blood is expected to increase, and vice versa is also true. Field et al. (1992) reported that a back massage significantly lowered the urine cortisol and norepinephrine levels. Though instead of urine, serum cortisol was measured in this study. The level of serum cortisol was lowered significantly after reflexology, which was consistent with previous results(Cho, 1999). However, even though the changes of serum cortisol level were statistically significant, it is difficult to say that these findings are clinically significant, because cortisol levels before and after foot reflexology were all within normal limits. The subjects were all within normal limit, and the levels were average or less. Therefore, even though foot reflexology is effective in decreasing perceived stress and the cortisol level, the effect size would be small, and it is difficult to expect clinical significance.

Lymphocytes are an important indicator of the immune function of the human body. Lymphocytes, one type of white blood cells, can be classified into T lymphocytes and B lymphocytes. While B lymphocytes(CD19) are related to humoral immunity, T lymphocytes(CD3) are related to cell mediated immunity and consist of several subsets such as helper/inducer T lymphocytes(CD4) and suppressor/cytotoxic T lymphocytes(CD8). It can be said that the immune function improves when the proportions of T lymphocytes and B lymphocytes increase, particularly the increase of helper T cells and decrease of suppressor T cells in numbers. The B cells

and NK(natural killer) cells, not the subsets of T lymphocyte but very similar to it, seem to increase when the immune function enhances(Park & Lee, 1998). Consistent with previous studies, the proportions of T lymphocyte, B lymphocytes and helper cells increased after reflexology in this study. However, suppressor T cell were not statistically significant. According to Bennett (1997) the situation and time of blood sampling can affect the levels of lymphocyte subsets or NK cells. Thus, we tried to solve this problem by limiting the sampling time to around 2~3 o'clock in the afternoon and using an experienced and well-trained nurse for blood sampling to minimize the discomfort related to needle sticks. There were sampling difficulties in some subjects because the general condition of some subjects was not good due to continuous chemotherapy, and this might have altered the results of the current study. The differences between pre and post were not clinically but statistically significant, and the reasons are similar to those of cortisol. Even though Diego et al(2001) and Ironson et al (1996) studied the effects of massage on immune functions among HIV patients, the improvement of immune function was not clinically significant or statistically significant. With all of these potential distractions the subsets of lymphocytes changed in the direction of improving the immune function but further research is needed to investigate the clinical significance.

The sample size of this study was relatively small, and the subjects were limited to female cancer patients. Moreover,



the current research adopted only an experimental group with no control and compared the differences just between pre and post reflexology, we could not rule out the effect of history and natural fluctuations (maturation). We hypothesized that cancer patients were high in cortisol level, and which would be related to the decreased immune function. But most study subjects were within normal limit of cortisol. Even though some could show high stress with lower cortisol level, this might influence the insignificant results. Further researches with subjects who show high level stress are needed to clarify the results. Additionally, an evaluation for the cumulative effects of repetitive foot reflexology is needed. Therefore, further detailed researches with various and larger samples are needed to generalize these results

## Conclusion

The current study was a pre-experimental research with only one experimental group to analyze the significant changes in vital signs, serum cortisol and the proportions of lymphocyte subsets and NK cells for studying the effects of foot reflexology on the stress and immune function of cancer patients receiving chemotherapy. 11 female cancer patients who had experiences of cancer chemotherapy were randomly selected from 2 university hospitals in Seoul. Foot reflexology was given to each subject on the day of admission. Vital signs were measured and blood samples were drawn to test for

the level of serum cortisol and the proportions of lymphocyte subsets and NK cells before and after foot reflexology. With the SPSSWIN program the obtained data was analyzed by Wilcoxon signed rank test, a nonparametric test for two related samples. The significance level was set at 0.05. The results show that post intervention level of SBP ( $p=.990$ ), DBP ( $p=.014$ ), pulse rate ( $p=.031$ ) and serum cortisol ( $p=.006$ ) decreased significantly to document that reflexology was effective to reduce the stress of female cancer patients. The proportions of total B lymphocytes ( $p=.049$ ) and helper T lymphocytes ( $p=.008$ ) increased significantly after reflexology, while the proportions of total T lymphocytes ( $p=.211$ ), suppressor T lymphocytes ( $p=.223$ ) and NK cells ( $p=.078$ ) did not change significantly. With the above results it can be concluded that reflexology does have a positive impact on the stress and immune function of female cancer patients.

Despite these encouraging results, it is difficult to generalize the findings of this study. Due to the small fund and the difficulty of recruiting study subjects, the sample size of the current study was relatively small and the subjects were limited to female cancer patients. The study could not give any information on the frequency and the time intervals for keeping the effects of foot reflexology because foot reflexology was given only once in this design. Further researches investigating the frequency and the long-term effects of foot reflexology with a larger sample size are needed.

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