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# Pain Relief Effect on Chronic Posterior Neck Pain Depending on the Types of Forests: Comparison between the Effects of Broadleaf and Coniferous Forests

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**Abstract** Posterior neck pain is a common symptom which one third of population experiences throughout one's lifetime. Recently, we achieved successful results that walking in the forest for two hours a day, five days for a week is effective on relieving chronic posterior neck pain. To ensure whether the pain relief effect on chronic posterior neck pain was due to the exercises or phytoncides, this study investigated whether the pain relief effect depends on types of forests. We enrolled total 64 subjects with chronic posterior neck pain and divided them into two groups; first group exercised in broadleaf forest (n=31) and the second group in coniferous forest (n=33). At the first day of the forest therapy, subjects had been examined as follows: VAS on the day, VAS for the past week, NDI, EQ VAS, EQ index, MPQ, TrP, and C-ROM. And these assessments were also evaluated at the last day of the forest therapy. There was no significant difference between two groups excepting EQ index (p=0.003) and range of motion of the cervical spine (C-ROM) (p=0.039) Forest healing program was effective on chronic posterior neck pain, but its effect on that pain showed no significant difference between broadleaf and coniferous forest groups.

**Keywords** Posterior neck pain, Musculoskeletal pain, Phytoncides, Forest therapy, Forest bathing

## 1. Introduction

Posterior neck pain is defined as pain in the posterior neck region caused by a problem in muscles, bones, ligaments, nerves, and joints [1]. It is known that 10% of people will have neck pain in any given month [1]. Although it is such a common symptom, if not treated well in the early stage, it might turn to chronic pain which makes it difficult to give accurate treatment. Failure of treatment which leads to long-term treatment not only causes individual patient's suffering and low quality of life (QOL) but also makes the family suffer and causes various social problems such as an increase in social cost [2]. For these reasons, various researches are ongoing to find treatment for posterior neck pain.

Phytoncides, a type of aroma that can be obtained from tree, shows relaxing effect and antibacterial effect during forest therapy [3, 4]. Kawakami et al. checked blood pressure between hypertensive rats that were exposed to phytoncides and were not exposed to it and it found out that groups exposed to phytoncides showed low blood pressure [3]. Li et al. found out natural killer (NK) activity was dose dependent to people who are exposed to phytoncides [5]. But the effect of phytoncides on musculoskeletal pain has not been stated.

Recently, we achieved successful results that walking in the forest for two hours a day, five days for a week is effective on relieving chronic posterior neck pain. However it was difficult to differentiate which part of forest healing program was particularly effective in relieving the chronic posterior neck pain. We assumed that a major part of forest healing program was the phytoncides from the forest. The Forests are classified into broadleaf forests and coniferous forests by its type and it is known that coniferous forests produce more phytoncides than broadleaf forests [6].

To ensure whether the pain relief effect on chronic posterior neck pain was different to the amount phytoncides, we investigated whether the pain relief effect depends on different types of forests. We also measured the temperature and the humidity of the two forests where study was proceeding. It aimed to find out whether these weather conditions had an effect on the result since cold temperature and dampness might act as a factor that worsens

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musculoskeletal pain [7].

## 2. Method

We recruited 70 volunteers with posterior neck for a month in May, 2013 by randomly calling patients that visited outpatient department of rehabilitation medicine in Hanyang University Medical Center, sending out e-mails and posting notices on the board. Of these 70 volunteers, 6 of them could not participate in the program due to personal reasons which made the experiment proceed with total of 64 subjects (Figure 1). Subjects all gave their informed consent voluntarily.

Inclusion criteria were as follows: posterior neck pain has been prolonged more than 3 months and was graded more than 4 in visual analogue scale (VAS) and aged more than 20. Exclusion criteria were as follows: poor knee joint state that make subject hard to walk more than an hour or acute inflammatory state in routine blood test.

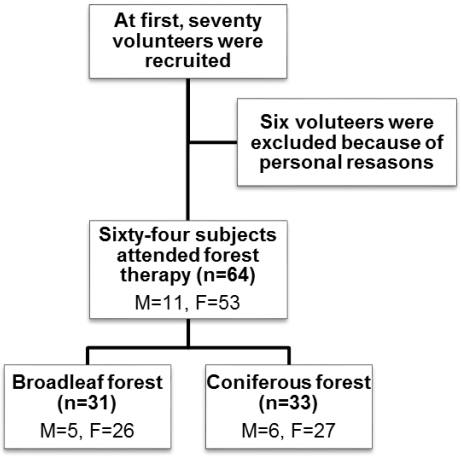


**Figure 1.** Patient flow diagram

To screen the subjects, we had done a workup of the simple radiography of cervical spine and both knee, routine blood test, and VAS on the day. On the first day and the last day of the forest therapy, subjects were examined as follows: 1) questionnaires; VAS on the day, VAS for the past week, neck disability index (NDI), EuroQol 5D-3L VAS (EQ VAS) and index (EQ index), and McGill pain questionnaire (MPQ), 2) physical examinations; the number of trigger point in posterior neck regions (TrP) and range of motion of the cervical spine (C-ROM) (Figure 2).

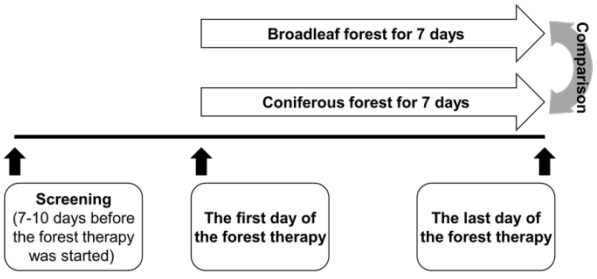


**Figure 2.** The flow chart showing schedule and plan of this study

VAS is commonly used to measure subjective level of pain [8]. It is consisted of a line of 10cm with no gradation and measures the overall length that subjects mark between 0 cm which implies no pain and 10 cm which implies extreme pain. VAS on the day measures the subjective level of posterior neck pain checked by the patient at that time point and VAS for the past week measures the subjective level of posterior neck pain on average during the past one week.

NDI is designed to give us information as to how your neck pain has affected your ability to manage in everyday life [9]. It is composed of 10 sections of questionnaires and each section has 6 multiple choice questions which are later converted to scores out of 50. Its reliability and validity are widely proven and it is valid for posterior neck pain [9].

EQ VAS and index is developed by EuroQol Group that allows to measure standardized health state [10]. EQ VAS makes subjects to answer the question 'Your own health state today' by marking their status from 0 to 100 on a line. 0 means the worst imaginable health state and 100 means the best imaginable health state. EQ index is composed of 5 sections such as mobility, self-care, usual activities, pain / discomfort, and anxiety/depression and makes subjects to answer 3 choices about their level of status which are later converted to scores by evaluation methods. The converted score is in between 0 and 1 and score closer to 1 means better health status.

McGill pain questionnaire makes subjects to choose appropriate expressions that indicate their pain well enough from various pain expressions. Each expression is valued differently and higher point implies severe pain by utilizing the summation of points from all the checked expressions [11].

Trigger point can be defined as a region where pain is felt when giving pressure under 4 kg/cm$^2$ by using pressure algometer [12]. We did a bilateral examination of 3 muscle regions of posterior neck including middle cervical paraspinal muscle, upper trapezius muscle, and infraspinatus muscle and found out the number of trigger points.

C-ROM uses inclinometer to examine ROM of 6 directions of cervical spine including sagittal plane, frontal plane, and rotation and used the summation to compare with other results.

All 64 subjects consisted of 11 male and 53 female were randomly divided into 2 groups of 31 people and 33 people considering their available time to participate in the experiment (Figure 1). First group with 31 people stayed in the Yonghyun natural recreation forest, a broadleaf forest, whereas second group with 33 people stayed in Saneum natural recreation forest, a coniferous forest. Both groups participated in 7-day/6-night forest program and walked in the forest every 2 hours a day (Figure 2).

During the forest therapy, we set up fixed-station transect of temperature sensors (HOBOs) at 12 places in Yonghyun and 7 places in Saneum to measure the temperature and humidity altogether. From second day to sixth day, every hour from 9 to 17, we collected climate data.

We compared the results between the two groups after participating in the walking program and residing in the forest. Also we compared the climate data collected from HOBOs between the two forests.

# 3. Results

Subjects who participated in the experiment were total of 64 people consisted of 11 male and 53 female, and they were divided into broadleaf forest group of 31 people and coniferous forest group of 33 people. Broadleaf forest group was composed of 5 male and 26 female and their age average showed as 51.7±13.19. Meanwhile, coniferous forest group was composed of 6 male and 27 female and their age average showed as 52.9±12.49. Screening test taken before 7-10 days from the beginning of the experiment showed average value of VAS on the day as 6.4±1.26 for broadleaf forest group and 5.9±1.33 for coniferous forest group and the minimum as 4.4 and 4.1 which satisfied inclusion criteria (Table 1).

**Table 1.** Subjects Characteristics

| Group | Male / Female | Age | VAS |
|---|---|---|---|
| Broadleaf forest | 5 / 26 | 51.7±13.1 | 6.4±1.3 |
| Coniferous forest | 6 / 27 | 52.9±12.4 | 5.9±1.3 |

The average VAS on the day of broadleaf forest group was improved from 5.4±1.5 examined before the program to 2.6±1.3 examined after the program and coniferous forest group revealed similar result showing the change from 5.2±1.7 to 2.4±1.6 (Table 2). To find out if improvements found in both groups after proceeding 7-day/6-night of forest residence and walking program showed any difference between the two groups, we compared the difference between before and after the program which turned out to have no significant difference (p=.851) (Table 3). In broadleaf forest group, average VAS for the past week of the examination in the first day showed as 5.8±1.5 and 2.7±1.4 in the last day while coniferous forest group showed positive changes from 5.7±1.6 to 3.0±1.5 (Table 2). However, when comparing the difference between the two groups, there was no significant difference (p=.405) (Table 3).

The average NDI on the examination in first day and the last day of the broadleaf forest therapy showed as 32.9±10.1 that improved to 18.5±9.8 and for the coniferous forest, the average NDI showed as 30.4±11.1 to 18.3±8.8 (Table 2). However, when comparing the difference between the two groups, it turned out that there was no significant difference (p=.485) (Table 3).

In the broadleaf forest, the average EQ VAS showed an improvement of health state which turned out as 48.1±18.7 before the program and 73.5±15.6 after the program, and it showed similar results as 50.0±15.2 to improvement of 75.0±15.0 in the coniferous forest (Table 2). EQ index in the broadleaf forest, the average was 0.68±0.17 before the program and 0.87±0.09 after the program and for the coniferous forest the average was 0.56±0.20 and 0.87±0.06 which both groups showed improvement of health state (Table 2). To confirm whether there was a quantitative difference in the improvement of health state between the two groups, we compared EQ VAS of the two groups which showed no significant difference (p=.642) and EQ index which turned out that the health state of coniferous forest group improved more significantly (p=.003) (Table 3).

The average score of MPQ in the broadleaf forest showed an improvement from 25.9±13.3 (before the program) to 9.2±7.4 (after the program). In the coniferous forest, it decreased from 23.2±11.9 to 13.0±11.1 which also showed an improvement (Table 2). However, when comparing the difference between the two groups, it revealed that there was no significant difference (p=.050) (Table 3).

The average number of trigger points was shown as 4.5±1.7 before the program and 2.6±1.6 after the program in the broadleaf forest and for the coniferous forest it showed 4.3±1.2 and 3.1±1.7 which both groups showed a significant decrease in TrP (Table 2). When comparing the degree of decrease in TrP between the two groups, it turned out to show no significant difference (p=.098) (Table 3).

**Table 2.** Evaluated Scales in Each Group

| | Broadleaf Forest Group | | Coniferous Forest Group | |
|---|---|---|---|---|
| | The first day of the forest therapy | The last day of the forest therapy | The first day of the forest therapy | The last day of the forest therapy |
| **VAS on the day**** | 5.4±1.5 | 2.6±1.3 | 5.2±1.7 | 2.4±1.6 |
| **VAS for the past week**** | 5.8±1.5 | 2.7±1.4 | 5.7±1.6 | 3.0±1.5 |
| **NDI**** | 32.9±10.1 | 18.5±9.8 | 30.4±11.1 | 18.3±8.8 |
| **EQ VAS*** | 48.1±18.7 | 73.5±15.6 | 50.0±15.2 | 75.0±15.0 |
| **EQ index*** | 0.68±0.17 | 0.87±0.09 | 0.56±0.20 | 0.87±0.06 |
| **MPQ**** | 25.9±13.3 | 9.2±7.4 | 23.2±11.9 | 13.0±11.1 |
| **TrP**** | 4.5±1.7 | 2.6±1.6 | 4.3±1.2 | 3.1±1.7 |
| **C-ROM*** | 235.0±69.2 | 330.0±86.1 | 279.5±65.2 | 345.2±69.1 |

* Positive variation of values mean improvement.
** Negative variation of values mean improvement

**Table 3.** Difference between Two Types of Forest (n=64)

| | Broadleaf forest (n=31) | Coniferous forest (n=33) | p-value |
|---|---|---|---|
| **VAS on the day**** | -2.8±1.9 | -2.8±1.7 | 0.851 |
| **VAS for the past week**** | -3.1±1.7 | -2.8±1.5 | 0.405 |
| **NDI**** | -14.4±10.1 | -12.1±10.6 | 0.485 |
| **EQ VAS*** | 25.4±19.8 | 25.0±10.6 | 0.642 |
| **EQ index*** | 0.18±0.13 | 0.31±1.89 | 0.003 |
| **MPQ**** | -16.7±13.7 | -10.2±9.4 | 0.050 |
| **TrP**** | -1.9±1.8 | -1.2±1.5 | 0.098 |
| **C-ROM*** | 95.0±62.1 | 65.8±53.8 | 0.039 |

* Positive variation of values mean improvement
** Negative variation of values mean improvement

Summation of ROM of all 6 directions of cervical region increased from 235.0±69.2° on average before the program to 330.0±86.1° on average after the program in the broadleaf forest and for the coniferous forest as well, the average increased from 279.5±65.2° to 345.2±69.1° (Table 2). When comparing the improvement of summation of ROM between the two groups, it turned out to show the broadleaf forest group had a significant improvement than the coniferous forest group (p=.039) (Table 3).

The average temperature and humidity were 22.0±2.5℃ and 81.0±16.8% checked in Yonghyun and Saneum during the forest therapy program. Saneum natural recreation forest with coniferous trees showed an average temperature of 24.6±1.9℃ and average humidity of 88.3±11.0% which had higher temperature of 2.6±2.5℃ and higher humidity of 7.3±17.0% compared to Yonghyun natural recreation forest with broadleaf trees (Table 4).

**Table 4.** Climate Data

| | Broadleaf forest | Coniferous forest |
|---|---|---|
| **The number of HOBOs*** | 12 | 7 |
| **Temperature (℃)** | 22.0±2.5 | 24.6±1.9 |
| **Humidity (%)** | 81.0±16.8 | 88.3±11.0 |

*HOBOs: fixed-station transect of temperature sensors

# 4. Discussion

There have been numerous studies about the physiologic effects of forests in human health. Forests increase parasympathetic nervous activity and suppress sympathetic nervous activity which make blood pressure and pulse rate decrease [13-15]. Also positive feelings are generated and negative feelings are reduced after the exposure to forest which gives positive effects to psychological health by making them feel “comfortable”, “calm”, and “refreshed” [13, 14] Some authors reported that just viewing trees could affect the human health [16, 17]. According to our previous study, forest therapy provides not only these effects but also helps to reduce musculoskeletal pain such as posterior neck pain. However, we could not find out by what mechanism allowed these pain relieving effects in that study.

This study was to investigate whether the pain relief effect on chronic posterior neck of the forest therapy depending on the type of forests. Phytoncide is defined as a substance that is produced from all kinds of plants and influences other organism [6]. Forests could be divided into basically two groups, one is broadleaf forest and the other is coniferous forest. It is widely known that amount of produced phytondices differs by the type of forest and coniferous forests produce more phytoncides than broadleaf forests [6]. Thus we compared the posterior neck pain relieving effect of the two groups with the same forest therapy program but in different forests. We figure out that these effects were due to phytoncides or to exercises or to other possible factors. Overall, since the current study showed no significant difference on the therapeutic effect of forest therapy, assuming the cause of the effect as phytoncide might not be a valid presumption.

We randomly divided subjects with posterior neck pain into two groups considering age, sex and VAS on the day from screening evaluation and made one group to stay in broadleaf forest and the other to stay in coniferous forest. Residing in different forest for 7-day/6-night, we proceeded same forest therapy program including forest walking program and later examined the results which both group showed improvement.

However, in order to confirm whether the pain relieving effect is influenced by the type of forest, we compared values from after the forest therapy program between the two groups which showed no significant difference except 2 indicators. Moreover these indicators showed the opposite results. Therefore, based on the results that we have found, we could conclude that forest therapy program does show a significant difference in improvement of posterior neck pain but the effect is not influenced by the type of the forest. Although it might seem like a hasty conclusion basing on the exposure to phytoncide for a short period of 7 days but since forest bathing is also commonly done for only a short period due to various reasons, our conclusion could have a significant meaning.

While forest therapy was proceeding in the two different forest, broadleaf forest had lower temperature whereas coniferous forest had higher humidity and the difference was marginal. Therefore considering the fact that cold and dampness act as factors that worsens the pain [7], it could be inferred climate factors did not have a significant effect on pain relief in our study.

## 5. Limitations

Although there was a pain relief effect on chronic posterior neck pain regardless of the forest type, it is questionable whether the pain relief effect was due to exercise programs or other potential factors. Therefore further studies are needed to investigate the current limitation.

## 6. Conclusions

A different type of forest in Forest healing program showed no difference in relieving the chronic posterior neck pain. Even though we did not measure the exact amount of phytoncides, it is widely known that there is a large difference in the amount of phytoncides each forest produces. This result may imply that the pain relief effect on chronic posterior neck pain is due to the exercises or other possible factors rather than phytoncides. Further research is needed to show other possible factor for relieving chronic neck pain in forest healing program.

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