

# Effectiveness of Aromatherapy for Relief of Pain, Nausea, and Vomiting after Percutaneous Nephrolithotomy: A Randomized Controlled Trial

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## Keywords

Aromatherapy · Lavender · Clary sage · Pain · Nausea and vomiting · Percutaneous nephrolithotomy

## Abstract

**Background:** Postoperative pain, nausea, and vomiting are common side effects of percutaneous nephrolithotomy. Nowadays, non-pharmacological and complementary therapies have been noticed. Therefore, a study was conducted to determine the effectiveness of lavender and clary sage on the pain, nausea, and vomiting after percutaneous nephrolithotomy. **Methods:** This is a randomized clinical trial study on 79 patients undergoing percutaneous nephrolithotomy. Patients were randomly divided into three groups of lavender aromatherapy ( $n = 27$ ), clary sage aromatherapy ( $n = 26$ ), and a control group ( $n = 26$ ). Each of the intervention groups received the inhalation aromatherapy immediately and 3 and 6 h after the operation. Pain, nausea, and emetic episodes in patients of the three groups were measured before the intervention and 30 min after each intervention using a visual analog scale and checklist. **Results:** Pain decreased significantly in the clary sage aromatherapy group. Nausea had a downward trend in the two groups of aromatherapy. The lavender aromatherapy group had the lowest incidence of emetic episodes compared to the other groups. **Conclusion:** Regarding the annoying pain, nausea, and vomiting after percutaneous nephrolithotomy for patients, and taking into account the complications of drug therapy, the use of complementary non-pharmacological methods can help increase the comfort of patients.

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## Wirksamkeit der Aromatherapie zur Linderung von Schmerzen, Übelkeit und Erbrechen nach perkutaner Nephrolithotomie: eine randomisierte kontrollierte Studie

## Schlüsselwörter

Aromatherapie · Lavendel · Muskatellersalbei · Schmerzen · Übelkeit und Erbrechen · Perkutane Nephrolithotomie

## Zusammenfassung

**Hintergrund:** Postoperative Schmerzen, Übelkeit und Erbrechen sind häufige Nebenwirkungen der perkutanen Nephrolithotomie. Heutzutage sind nicht-pharmakologische und komplementäre Therapien bekannt. Daher wurde eine Studie durchgeführt, um die Wirkung von Lavendel und Muskatellersalbei auf Schmerzen, Übelkeit und Erbrechen nach perkutaner Nephrolithotomie zu ermitteln. **Methoden:** Bei der vorliegenden Untersuchung handelt es sich um eine randomisierte klinische Studie mit 79 Patienten, bei denen eine perkutane Nephrolithotomie durchgeführt wurde. Die Patienten wurden randomisiert drei Gruppen zugeordnet: eine Gruppe erhielt eine Aromatherapie mit Lavendel ( $n = 27$ ), eine Gruppe erhielt eine Aromatherapie mit Muskatellersalbei ( $n = 26$ ) und eine Gruppe diente als Kontrolle ( $n = 26$ ). Bei beiden Interventionsgruppen erfolgte die Inhalationsaromatherapie unmittelbar postoperativ sowie 3 und 6 Stunden nach dem Eingriff. Vor der In-

tervention sowie 30 Min danach wurden bei den Patienten der drei Gruppen Schmerzen, Übelkeit und emetische Episoden anhand einer visuellen Analogskala und Checkliste ermittelt. **Ergebnisse:** In der Gruppe mit Muskatellersalbei-Aromatherapie kam es zu einem signifikanten Rückgang der Schmerzen. Bei der Übelkeit war in beiden Aromatherapiegruppen ein rückläufiger Trend zu beobachten. Die Lavendel-Aromatherapiegruppe zeigte im Vergleich zu den anderen Gruppen die niedrigste Inzidenz emetischer Episoden. **Schlussfolgerung:** In Hinblick auf die für die Patienten unangenehmen Schmerzen, die Übelkeit und das Erbrechen nach perkutaner Nephrolithotomie und angesichts der Komplikationen der medikamentösen Therapie können komplementäre, nicht-pharmakologische Methoden helfen, den Patientenkomfort zu erhöhen.

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## Background

Kidney stones have always been considered as an old problem for health. The risk of developing kidney stones is about 10–15% of the people in developed countries and 20–25% in the Middle East countries. In addition to the incidence of kidney stones, the rate of its recurrence is high [1]. In the case of no treatment, patients will be threatened with serious problems, such as metabolic disorders and kidney failure [2].

Renal open surgery is one of the known methods for the treatment of large renal stones, which is associated with many complications. Today, the rate of open surgery has declined in the world, and less invasive treatments have replaced it [3]. Percutaneous nephrolithotomy (PCNL) is a less invasive treatment of kidney stones, which was first reported by Fernström and Johansson in 1976 [4] and it is now considered as a standard method [3, 5]. Most urologists believe that this method is preferable to renal open surgery due to less duration of hospitalization, less bleeding, fewer complications, and greater renal function [6]. However, PCNL, like other surgeries, has annoying effects, such as pain, nausea, and vomiting [7, 8].

Pain is an unpleasant feeling and paying attention to pain is very important because, in addition to making patients anxious, it has negative psychological effects [9]. Post-PCNL pain is an annoying sense that may originate from the capsule of the kidney, muscle, subcutaneous tissue, and skin [7].

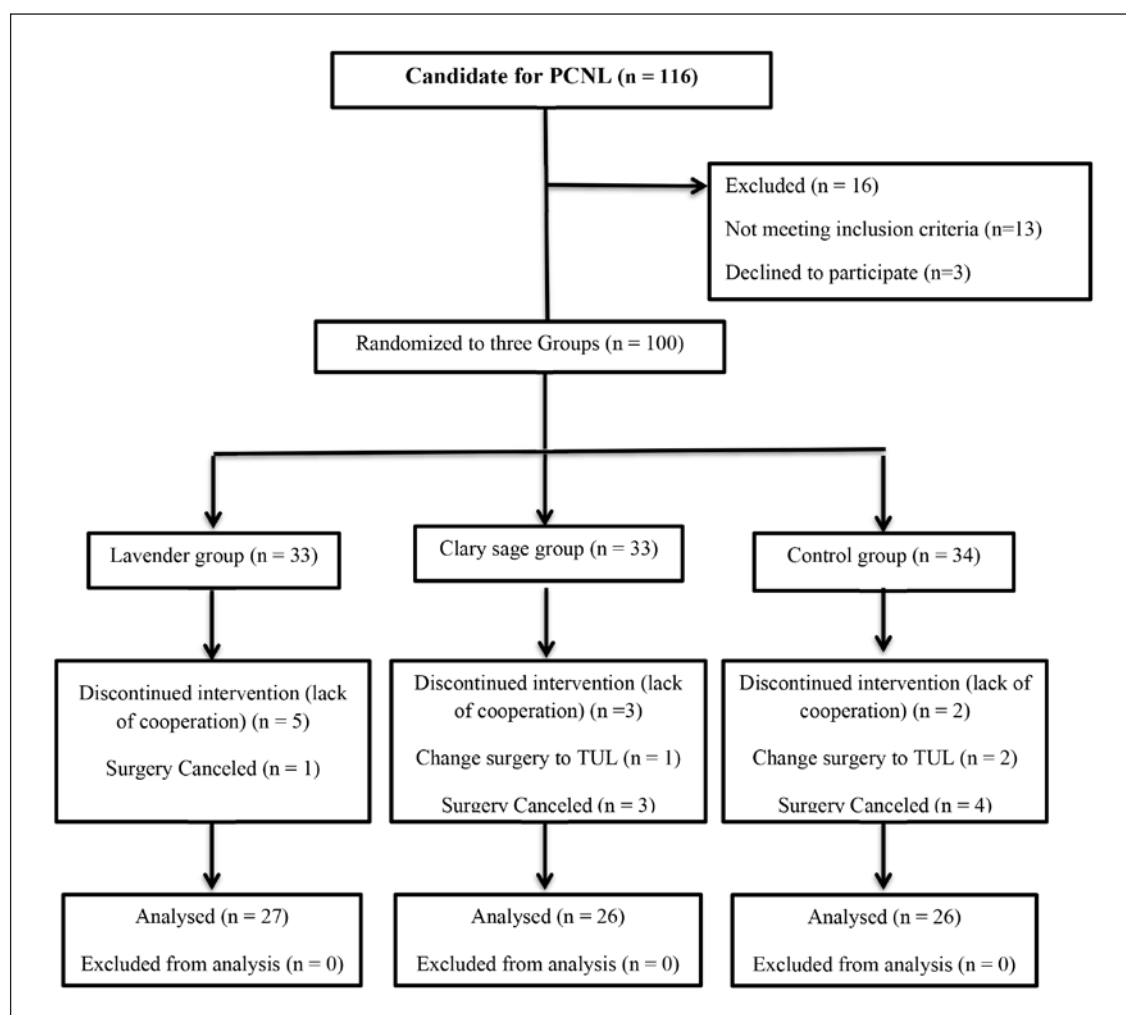
Postoperative nausea and vomiting (PONV) are other concerns after surgery under general anesthesia. The risk of developing PONV in predisposed people, such as Ménière syndrome, rises by about 70% to 80%. Also, the history of migraine, female gender, type of operation, and its duration are effective in developing PONV [10]. If PONV is not treated, it will cause complications such as dehydra-

tion, electrolyte disturbances, and aspiration, and thus, the patient's delayed discharge from the hospital [11].

One of the basic measures of the treatment team in controlling postoperative pain, nausea, and vomiting is to manage the use of medications and appropriate palliative methods, and their security and effectiveness should be considered. Pharmacological and non-pharmacological methods are used to relieve pain. Narcotics are one of the commonly used pharmacological methods that in addition to reducing pain cause side effects such as nausea, vomiting, drowsiness, respiratory distress, urinary retention, and constipation [7]. As anti-nausea medications also cause potentially negative effects, such as drowsiness, changes in blood pressure, and electrocardiographic changes, drug therapy will cause unpleasant complications, in addition to increasing therapeutic costs [11, 12].

Over the past 25 years, a powerful movement around the world has developed that integrates traditional safe, effective, and self-care practices into mainstream health care [13]. One of the available non-pharmacological methods is a complementary medicine and the reasons for the complementary medicine use are complex, and holistic worldviews seem to play an important role in seeking complementary medicine therapies rather than scientific evidence [12, 14]. In the aromatherapy, the absorption of the relevant substance causes changes in the limbic system (a part of the brain that is associated with sensation and memory), which in turn stimulates the physiological response of the nerves, endocrine, and the immune system, and influences heart rate, blood pressure, respiration, the activity of brain waves, and the release of various hormones. In this way, herbal oil is used, which is absorbed through the skin and the respiratory system [15]. Inhalation aromatherapy is one of the most commonly used methods, which is used by inhalation through an oxygen mask or diffusion in the room [16].

One of the essential oils used in aromatherapy is *Lavandula angustifolia* L. Several studies have reported the effect of lavender on pain relief in cases such as fatigue of hemodialysis, painful menstruation, and end-stage cancer [17]. But the effect of lavender oil has not been studied on postoperative complications of renal surgery (pain, nausea, and vomiting). Clary sage is another of the essential oils used in aromatherapy that refers to clary sage (*Salvia sclarea* L.). This herb is used as an effective medicine in reducing blood glucose with sedative and analgesic effects. Clary sage is considered due to its antibacterial, antifungal, and antioxidant properties and nervous system enhancement [18]. According to Hodge et al. [19], the inhalation aromatherapy with a combination of lavender, mint, and ginger could significantly reduce nausea and vomiting in patients undergoing chemotherapy. But the effect of clary sage oil has not been studied on postoperative complications of renal surgery (pain, nausea, and vomiting).



**Fig. 1.** Explanation of sample size and sampling.

Today, complementary medicine is growing in the world, but it has been underestimated in Iran, and sometimes the treatment team does not have much information about it. Since patients have severe pain, nausea, and vomiting after the PCNL, these postoperative complications affect the comfort and relaxation of the patients negatively. On the other hand, no research was found to study the comparison and effect of the aromatherapy on the complications caused by renal surgeries. A study was done to determine the effectiveness of lavender and clary sage aromatherapy on pain, nausea, and vomiting of patients after PCNL.

## Methods and Materials

### Study Type and Setting

It is a randomized clinical trial study conducted on candidates for PCNL in Shahid Bahonar Hospital, one of the largest surgical centers in southeast Iran.

### Sample Size and Sampling

According to the previous study (nausea score:  $\mu_1 = 5.72$ ,  $\mu_2 = 2.72$ ,  $S_1 = 3.26$ , and  $S_2 = 3.12$ ) [19], 78 patients (26 patients in each group) were powered enough (80%) to detect a mean difference of nausea score of 3. In this study of 116 PCNL patients, 100 patients met the inclusion criteria. Of these, 3 patients were excluded because of a change in the type of operation from PCNL to TUL, 8 patients were suspended, and 10 patients were excluded because of delay in initiation of surgery. Finally, 79 patients participated in the study. Patients were assigned to an intervention group of lavender ( $n = 27$ ), intervention group of clary sage ( $n = 26$ ), and control group ( $n = 26$ ) using the randomized block design (Fig. 1).

Inclusion criteria include ages between 18 and 65 years, absence of coagulation disorders, no migraine, no chronic headache, no allergy to medicinal plants and aromatic substances, no use of sedatives and aromatherapy in the last week, no history of asthma and respiratory problems, and no mental and psychological problems. Exclusion criteria include cardiopulmonary disorders and transmission to CCU and ICU, discharge before the end of the intervention period, creating skin and respiratory allergy in the patient, and eliminate more than one intervention for any reason. The enlistment began on September 10, 2018 and ended on July 24, 2019.

**Table 1.** Patients' characteristics in the three groups (lavender, clary sage, and control)

Variable	Lavender group		Clary sage group		Control group		Statistic test	p value
	n	%	n	%	n	%		
Sex								
Female	10	37	8	30.8	9	34.6	0.24*	0.89
Male	17	63	18	69.2	17	65.4		
Education								
Illiterate	4	14.8	2	7.7	1	3.8	11.29**	0.02
Middle and diploma	14	51.9	18	69.2	8	30.8		
Bachelor and master	9	33.3	6	23.1	17	65.4		
Marital status								
Married	24	88.9	25	96.2	25	96.2	1.4**	0.61
Single	3	11.1	1	3.8	1	3.8		
Income								
Less than 10,000,000 rials	3	11.1	3	11.5	1	3.8	1.74**	0.86
10,000,000–30,000,000 rials	21	77.8	21	80.8	23	88.5		
More than 30,000,000 rials	3	11.1	2	7.7	2	7.7		
Employment								
Employed	11	40.7	9	34.6	6	23.1	1.92*	0.4
Unemployed	16	59.3	17	65.4	20	76.9		

\* Chi-square. \*\* Fisher's exact test.

#### Assessment Tools

In this research, demographic and background information was collected by a questionnaire including age, sex, marital status, monthly income, education, occupation, type of education, history of surgery, underlying illness, medication regimen, type of anesthesia, type and dosage of anesthetic, addiction, use of special medications, the postoperative dosage of analgesics, anti-nausea, and antiemetic medications, complete implementation of aromatherapy and the reason for its incomplete implementation, the level of blood pressure, and heart rate.

The intensity of pain and nausea was assessed by visual analog scale [20]. This scale, which is a horizontal ruler and has been divided from 0 to 10, was developed by Milzak in 1975 [21]. It has been tested in numerous studies and is now considered as one of the scales for pain and nausea. In this study, firstly, patients were trained on how to use this scale, and then their pain intensity was recorded before and 30 min after each intervention. The score of zero indicates the lowest intensity of pain and nausea, and the score of 10 shows the highest intensity of pain and nausea. However, each of the variables of pain and nausea was examined separately [22]. This scale is a well-known tool and has been used frequently in research, and its validity and reliability have been verified.

According to Kim et al. [23], Cronbach's alpha of nausea, vomiting, retching, and total experience scores of the Rhodes index of nausea, vomiting and retching (RINVR) ranged from 0.912 to 0.968. Test-retest scores of all items were strongly correlated (Spearman's coefficients: 0.962–1.000,  $p < 0.0001$ ) and highly agreed (weighted kappa: 0.932–1.000). Coefficients of construct validity for nausea components (vs. visual analog scale for nausea) and emetic components (vs. incidence of emetic episodes) of the RINVR were 0.860–0.928 and 0.724–0.811, respectively ( $p < 0.0001$ ) [23]. The emetic episodes were also examined based on the checklist.

#### Data Collection and Intervention

The researcher first received permission from the head of the hospital and the person in charge of the operative room and urology department. Then she came to the urological department and completed the demographic and background information of the patients who met the inclusion criteria after obtaining informed written consent from the patients and before the intervention. After the operation, transfer of the patient to the recovery room, and waking up, the patient's vital signs were checked to control his condition, then the intensity of pain, nausea, and the emetic episodes of patients were measured and the intervention was done by the first researcher with the supervision of the doctor. Therefore, the researcher soaked a sterilized gauze with three drops of the desired aromatic (lavender or clary sage) and placed it within 10 cm of the patient's nose and asked him to inhale it for 5 min. The second researcher measured the rate of pain, nausea, and vomiting of the patient 30 min after the intervention, and it was repeated for each patient 3 and 6 h after the operation, and the variables were re-measured 30 min after each intervention. These times were selected based on similar articles and the opinions of the urologist and anesthesiologist [24, 25]. The second intervention (3 h after surgery) and the third one (6 h after surgery) were performed in the urological department because the patient was transferred there. Patients in the control group were evaluated for the intensity of pain, nausea, and vomiting after waking up and 3 and 6 h after surgery. No intervention was done in the control groups, and they received routine care. They were provided with an oxygen mask and were treated with medication in the event of pain, nausea, and vomiting, according to the physician's order, and information was recorded. Meanwhile, the dosage and type of medications were recorded 6 h after surgery in each of the intervention and control groups (Tables 1–3).

Lavender essential oil and clary sage essential oil with 100% oil essence were obtained from Barij Essential Oil Company of Kashan. According to the researcher's suggestion and to ensure the purity, the concentration, and the main components of these es-

**Table 2.** Patients' clinical characteristics in the three groups (lavender, clary sage, and control)

Variable	Lavender group		Clary sage group		Control group		Statistic test	p value
	n	%	n	%	n	%		
Addiction								
Yes	8	29.6	5	19.2	6	23.1	0.80*	0.72
No	19	70.4	21	80.8	20	76.9		
History of surgery								
Yes	15	55.6	15	57.7	19	73.1	2.04*	0.40
No	12	44.4	11	42.3	7	26.9		
Kind of surgery								
Kidney stone	5	33.3	8	53.3	12	63.2	5.7**	0.22
Other surgery	7	46.7	3	20.0	6	31.6		
Both	3	20.0	4	26.7	1	5.3		
Disease history								
Yes	8	29.6	7	26.9	7	26.9	0.06*	>0.99
No	19	70.4	19	73.1	19	73.1		
Drugs								
Yes	21	77.8	21	80.8	22	84.6	0.40*	0.94
No	6	22.2	5	19.2	4	15.4		
Anesthesia drug								
Routine drug	17	63.0	16	61.5	19	73.1	2.81**	0.91
Routine drug and morphine	8	29.6	7	26.9	5	19.2		
Routine drug and BP drug	1	3.7	1	3.8	0	0.0		
Routine drug and both	1	3.7	2	7.7	2	7.7		
Surgery time								
1 h	4	14.8	0	0.0	1	3.8	8.71**	0.15
1.5 h	10	37.0	10	38.5	6	23.1		
2 h	10	37.0	14	53.5	18	69.2		
2.5 h	3	11.1	2	7.7	1	3.8		

\* Chi-square. \*\* Fisher's exact test.

sential oils, they were analyzed in the laboratory of the company and then purchased by the researcher. The main constituents of lavender oil were linalool (30.6%), 1,8-cineole (20.9%), and bornenol (8.9%). The main components of clary sage were linalool (30.03%), linalyl acetate (23.08%), a-terpineol (11.13%), geraniol (8.37%), and neryl acetate (4.69%).

#### Data Analysis

SPSS 25 was used. Descriptive statistics were used to describe the demographic and clinical characteristics of the research units and other variables in the study. ANOVA, chi-square, and Fisher tests were used to compare the demographic and clinical characteristics of the patients among the three groups. Friedman and Kruskal-Wallis tests were used to compare pain and nausea scores in each group and among the three groups of intervention and control. Fischer test was used to compare the emetic episodes among the three groups of intervention and control.

## Results

The mean age of patients in the lavender, clary sage, and control groups was 42.22, 43.27, and 42.81, respectively, and there was no significant difference among the three groups in this regard. Most participants in the study

were male, married, employed, with 10,000,000–30,000,000 rials of income, and they had middle and diploma degrees in the two groups of intervention and bachelor and master degrees in the control group, but there was no significant difference among the groups in all of these variables except for education, and the three groups were matched (Table 1). Most patients in the three groups had no history of addiction and had a history of surgery and underlying illness. Most patients took routine drugs. The duration of surgery for most people in each of the three groups was between 1 and 2 h. There was no significant difference among the groups in all of these variables (Table 2). The most commonly used drug for the three groups was diclofenac and morphine, and most of them in the three groups did not use ondansetron and metoclopramide. There was no significant difference among the groups in all of these variables (Table 3).

According to Table 4, the mean and median scores of pain in the three groups had a downward trend. There was a downward trend in the pain score of the lavender group and this rate was significantly different at different times ( $p = 0.047$ ). The mean and median scores of pain in the clary sage group significantly decreased at different



**Table 3.** Taking analgesics and other medications in the three groups (lavender, clary sage, and control)

Variable	Lavender group		Clary sage group		Control group		Statistic test	<i>p</i> value
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Pethidine								
Yes	1	3.7	1	3.8	4	15.4	2.75**	0.31
No	26	96.3	25	96.2	22	84.6		
Morphine								
Yes	4	14.8	6	23.1	4	15.4	0.78**	0.76
No	23	85.2	20	76.9	22	84.6		
Acetaminophen supp.								
Yes	3	11.1	1	3.8	1	3.8	1.4**	0.61
No	24	88.9	25	96.2	25	96.2		
Diclophenac supp.								
Yes	16	59.3	14	53.8	15	57.7	0.17*	0.96
No	11	40.7	12	46.2	11	42.3		
Apotel								
Yes	2	7.4	6	23.1	3	11.5	2.65**	0.26
No	25	92.6	20	76.9	23	88.5		
Metoclopramide								
Yes	0	0.0	0	0.0	1	3.8	1.87**	0.66
No	27	100.0	26	100.0	25	96.2		
Ondansetron								
Yes	0	0.0	1	3.8	1	3.8	1.32**	0.54
No	27	100.0	25	96.2	25	96.2		
BP drugs								
Yes	0	0.0	1	3.8	1	3.8	1.32**	0.54
No	27	100.0	25	96.2	25	96.2		

\* Chi-square. \*\* Fisher's exact test.

times ( $p = 0.001$ ). The mean and median scores of pain in the control group had a downward trend at different times ( $p = 0.002$ ). Therefore, according to the results of pain reduction in all three groups, there was no significant difference among the three groups after surgery, 30 min after surgery, and 6 h after surgery ( $p > 0.05$ ). The pain difference between the three groups 3 h after surgery was significantly different ( $p = 0.04$ ). The lowest mean nausea score 3 h after the operation was related to the lavender group.

Table 5 shows that the median score of nausea was zero in all groups and all measurements. Also, the mean score of nausea was lower in the two intervention groups, and the downward trend was greater in the lavender aromatherapy group, especially 3 and 6 h after surgery, while the nausea rate in the control group had an upward trend. But these differences were not significant among the groups ( $p > 0.05$ ). It should be noted that the nausea difference in the three groups 6 h after surgery was 0.05. Since the highest mean nausea score 6 h after the operation was related to the control group, it can be considerable.

According to Table 6, 74.1% of the patients in the lavender group, 50% of the patients in the clary sage group, and 54% of the control group did not vomit during the

study, which was significantly higher in the lavender group than the other groups (the median was zero in all groups). In terms of the emetic episodes, 25.9 of the patients in the lavender group had only one emetic episode, while in the clary sage group, 30.8% of the patients had one emetic episode, 15.4% had two emetic episodes, and 3.8% had three emetic episodes. In the control group, 11.5% of the patients had one emetic episode, 11.5% had two emetic episodes, 11.5% had three emetic episodes, and 11.5% had four emetic episodes. There were significant differences in the emetic episodes among the three groups ( $p = 0.02$ ) (Table 5).

## Discussion

The present study was conducted to investigate the effect of lavender and clary sage aromatherapy on pain, nausea, and vomiting of patients after PCNL.

The results of this study showed that 3 h after surgery, the mean score of pain had a significant difference in all three groups. Also, pain reduction was considerable with lavender and clary sage aromatherapy at different times. In agreement with these results, Hur et al. [26] found that

**Table 4.** The mean score of pain at different times between the three groups (lavender, clary sage, and control)

Pain	Lavender group			Clary sage group			Control group			Effect size	Kruskal-Wallis H test	<i>p</i> value
	median	mean	SD	median	mean	SD	median	mean	SD			
After surgery	4.00	4.52	4.44	8.00	6.27	4.38	9.50	6.77	4.22	0.96	3.86	0.14
30 min after surgery	7.00	6.15	3.45	7.00	5.92	4.06	9.50	7.58	3.29	1.64	3.66	0.16
3 h after surgery	5.00	4.52	2.56	5.50	5.69	2.85	8.00	6.64	3.22	0.87	6.62	0.04
6 h after surgery	4.00	3.78	2.76	3.00	3.52	2.96	5.00	4.92	3.17	0.61	3.28	0.19
Friedman test	7.95			15.84			15.20					
<i>p</i> value	0.047			0.001			0.002					

**Table 5.** The mean score of nausea at different times in the three groups (lavender, clary sage, and control)

Nausea	Lavender group			Clary sage group			Control group			Effect size	Kruskal-Wallis H test	<i>p</i> value
	median	mean	SD	median	mean	SD	median	mean	SD			
After surgery	0.00	1.04	2.56	0.00	1.27	3.13	0.00	1.50	1.16	0.19	0.02	0.99
30 min after surgery	0.00	1.59	2.92	0.00	0.65	1.70	0.00	1.69	3.18	0.47	1.21	0.55
3 h after surgery	0.00	0.74	1.43	0.00	1.46	2.92	0.00	2.16	3.16	0.90	2.27	0.32
6 h after surgery	0.00	0.44	1.93	0.00	0.96	2.28	0.00	2.31	3.59	0.87	5.94	0.05
Friedman test	5.68			1.06			1.49					
<i>p</i> value	0.13			0.79			0.68					

**Table 6.** The number of vomiting during the study between the three groups (lavender, clary sage, and control)

Vomiting	Lavender group		Clary sage group		Control group		Fisher's exact test	<i>p</i> value
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
0	20	74.1	13	50.0	14	54.0	15.02	0.02
1	7	25.9	8	30.8	3	11.5		
2	0	0.0	4	15.4	3	11.5		
3	0	0.0	1	3.8	3	11.5		
4	0	0.0	0	0.0	3	11.5		

massage therapy with clary sage, marjoram, cinnamon, and ginger diluted with almond oil was significantly effective in reducing the pain of menstruation in Korean girls compared to acetaminophen. Dimitriou et al. [27], in a systematic review of nine studies, reported that inhalation or massage aromatherapy reduced postoperative pain significantly. In this study, the researchers confirmed the aromatherapy as a low-cost complementary medicine with fewer complications [27]. The study of Arjmand et al. [28] in Iran found that lavender aromatherapy compared to aromatherapy with almond oil in the control group significantly reduced the pain caused by discectomy in four different times. The researcher has suggested that since pain reduction in the early hours is

not very effective, it can be used as an effective way to reduce moderate to severe pain [28]. Aromatherapy excretes endorphins into the plasma, which can reduce stress hormone levels. It also increases the secretion of the neurotransmitter serotonin and enhances parasympathetic activity, which reduces pain [29]. When essential oils are inhaled, they have the fastest effect because it takes only a few seconds for the chemicals to reach the brain. Thus, inhaled essential oils may affect the central nervous system, thereby reducing the autonomic response to painful stimuli [30]. Based on this study, it can be said that aromatherapy is effective in acute postoperative pain and can be used to control pain at postoperative hours.

Based on the results of this study, the nausea rate in the two groups of the intervention had a downward trend, while it had an upward trend in the control group, who did not receive the aromatherapy, but there was no significant difference in the mean score of nausea among the three groups at different times. However, the three groups had a significant difference in the emetic episodes, so that lavender aromatherapy significantly reduced the emetic episodes compared to the clary sage and the control groups. Linalool and linalyl acetate in lavender can stimulate the parasympathetic system, and linalyl acetate has narcotic properties and linalool acting as a sedative [31, 32]. Pharmaceutical treatments are often associated with unpleasant side effects and aromatherapy provides a potential alternative therapy for the management of nausea without the side effects [33]. Evidence exists that relaxation reduces the body's response to norepinephrine. Therefore, the involvement of the hypothalamus in the actions of aromatherapy is the integrator between mind and body [30]. A similar study by Hodge et al. [19] found that the inhalation aromatherapy with lavender, peppermint, and ginger significantly reduced PONV. Salmani et al. [34] in similar results also found that nausea severity had a downward trend in groups of lavender aromatherapy and oxygen therapy in the control group. However, this downward trend was greater in the intervention group, and emetic episodes significantly decreased in the lavender aromatherapy group [34]. Ferruggiari et al. [35] in the United States reported that nausea rate was not significantly different in the three groups of peppermint aromatherapy, placebo, and injection of ondansetron at the 5th and 10th minutes after surgery.

This research had some limitations. Firstly, the rate of nausea and pain was examined by a self-reported scale, and given that the threshold of tolerance varies from one person to another, it might affect the results, which was similar for all individuals in the three groups. It was tried to explain it to the individuals before collecting data. Secondly, the low number of patients might affect the results, and we included a suggestion to conduct a similar study with a larger sample size for future studies.

## Conclusion

In general, the present study showed that the clary sage aromatherapy reduces the pain after PCNL gradually and considerably. The amount of postoperative nausea is also reduced gradually by the clary sage and lavender aromatherapies, while the postoperative emetic episodes in lavender aromatherapy significantly reduced compared to the clary sage.

Since the intensity of pain and especially nausea and vomiting is high after nephrolithotomy and, on the other

hand, these complications are very annoying to patients, and even the vomiting can exacerbate pain, caregivers need to have the necessary knowledge about non-pharmacological interventions and use them for the comfort of patients after PCNL. It is recommended that health planners train the members of the treatment team, in particular those in the operating, recovery rooms, and surgical departments.

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## Statement of Ethics

The ethics committee of Kerman University of Medical Sciences approved the study (ethics code No. IR.KMU.REC.1397.086), which was conducted ethically in accordance with the World Medical Association Declaration of Helsinki (trial registration No. IRCT20180321039135N1). Subjects have given their written informed consent and the study protocol was approved by the institute's committee on human research. They were assured that their personal information would remain confidential. After the end of the study, the control group was trained about the benefits of using herbal medicines.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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## Author Contributions

P.M.S. and M.A. contributed to the original idea and protocol, the conception of the work, conducting the study, revising the draft, approving the final version of the manuscript, and agreed to all aspects of the work. M.D. was involved in data analysis, drafting of the manuscript, and approval of the final version of the manuscript. H.P. contributed to the design of the work, the draft revision and approval of the final version of the manuscript. All authors have read and approved the manuscript.



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