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# Effectiveness of 2% Lidocaine Combined with Acupressure on Anxiety, Stress, and Pain Levels During Pleural Puncture Procedures

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## ABSTRACT

**Background:** Pleural puncture (thoracentesis) often causes anxiety, stress, and pain. Although 2% lidocaine is commonly used for analgesia, its effect on psychological distress is limited. Acupressure may help reduce both pain and emotional discomfort. This study evaluated the effectiveness of 2% lidocaine combined with acupressure in patients undergoing pleural puncture.

**Subjects and Method:** A randomized controlled trial was conducted on 36 patients undergoing pleural puncture at Dr. Moewardi Regional General Hospital, Surakarta, Indonesia. Patients were allocated to three groups: Control (2% lidocaine 4 cc), Treatment 1 (2% lidocaine 4 cc + acupressure), and Treatment 2 (2% lidocaine 2 cc + acupressure). Acupressure was applied 20 minutes prior to the procedure at points PC6, Yintang (EX-HN3), Hegu (LI4), and Baihui (GV20). Anxiety, stress, and pain were assessed using DASS-21 and Numeric Rating Scale (NRS) before and after the procedure. Data were analyzed using Shapiro-Wilk normality test, Levene homogeneity test, ANOVA, paired t-test, and post hoc LSD test.

**Results:** Anxiety scores were lower in treatment 1 (Mean=5.66; SD=2.38) and treatment 2 (Mean=5.16; SD=2.48) than in the control group (Mean=8.00; SD=3.07; p=0.009). Stress scores were also lower in treatment 1 (Mean=4.50; SD=2.27) and treatment 2 (Mean=4.33; SD=2.53) versus control (Mean=7.16; SD=3.01; p=0.001). Pain scores were reduced in treatment 1 (Mean=1.50; SD=1.31) and treatment 2 (Mean=1.33; SD=0.88) compared with control (Mean=2.91; SD=1.67; p=0.036). No significant differences were found between treatment groups (p>0.05).

**Conclusion:** Acupressure combined with 2% lidocaine effectively reduces anxiety, stress, and pain during pleural puncture. Lower-dose lidocaine provided comparable outcomes when combined with acupressure.

**Keywords:** acupressure, anxiety, lidocaine, pleural puncture, pain

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## BACKGROUND

Pleural effusion is a common clinical condition associated with a wide range of diseases, including tuberculosis, malignancy, heart failure, and pneumonia. The condition can cause significant respiratory symptoms, particularly dyspnea, chest discomfort, and reduced quality of life. Thoracentesis is an essential diagnostic and therapeutic procedure used to identify the underlying cause of pleural effusion and alleviate symptoms by removing excess pleural fluid (Sutanto et al., 2020). Approximately 1.5 million thoracentesis procedures are performed annually in the United States, while pleural effusion remains a substantial healthcare burden in Indonesia, particularly in patients with tuberculous pleuritis (Krishna et al., 2024; Ministry of Health of the Republic of Indonesia, 2023).

Although thoracentesis is generally considered safe and minimally invasive, the procedure is not without complications. Patients may experience pain, bleeding, infection, vasovagal reactions, and pneumothorax, with reported pneumothorax rates ranging from 12% to 30% depending on procedural technique and patient characteristics fluid (Sutanto et al., 2020). Beyond physical complications, the anticipation of needle insertion and the invasive nature of the procedure frequently induce psychological distress among patients (Shechtman et al., 2020).

Anxiety and stress are common responses before invasive medical procedures and may substantially influence patient experiences and clinical outcomes. Previous studies have reported that preprocedural anxiety affects approximately 60%–80% of patients undergoing medical interventions and is associated with heightened pain perception, increased sympathetic nervous system activity, and prolonged recovery (Shewangzaw et al., 2022; Mulugeta et al., 2018). Activation of the hypothalamic-pituitary-adrenal (HPA) axis during stressful situations stimulates the release of cortisol and catecholamines, which may further intensify pain perception and emotional discomfort (Kudielka and Kirschbaum, 2005).

Effective management of procedural discomfort therefore requires an approach that addresses both physical pain and psychological distress. In current clinical practice, local anesthetics are routinely administered to minimize pain during thoracentesis. Lidocaine 2% is the most commonly used local anesthetic because of its rapid onset, favorable safety profile, and ability to block voltage-gated sodium channels, thereby inhibiting nociceptive signal transmission. The maximum recommended dose is approximately 3 mg/kg body weight (Halili et al., 2020; Silva et al., 2023).

Despite its effectiveness in reducing procedural pain, lidocaine has limited effects on anxiety and stress. Consequently, patients may continue to experience substantial emotional discomfort even when adequate local anesthesia is achieved. This limitation has encouraged the exploration of complementary non-pharmacological interventions that can improve patient comfort while maintaining procedural safety and minimizing medication-related adverse effects (Du et al., 2023).

Acupressure is a non-invasive intervention derived from Traditional Chinese Medicine that involves applying pressure to specific acupoints to stimulate physiological responses. Previous studies have suggested that acupressure may promote the release of endogenous opioids, including endorphins and enkephalins, reduce cortisol levels, and enhance parasympathetic nervous system activity, thereby contributing to pain relief and emotional relaxation (Mostafa &

Fathallah, 2020; Liu et al., 2023). Several acupoints, including Hegu (LI4), Baihui (GV20), Yintang (EX-HN3), and Neiguan (PC6), have been reported to exert analgesic, anxiolytic, and stress-reducing effects through neurophysiological mechanisms (Focks, 2008; Kwon and Lee, 2018).

Previous studies have demonstrated the beneficial effects of acupressure in reducing pain and anxiety among patients undergoing various invasive procedures, including cardiac catheterization, chest tube removal, bone marrow biopsy, and brachytherapy (Bastani et al., 2016; Sharifi Rizi et al., 2017; Alizadeh and Takasi, 2024; Dahmardeh, 2024; Duzova et al., 2025).

However, evidence regarding the combined use of lidocaine and acupressure during thoracentesis remains limited. To the best of our knowledge, no previous study has specifically evaluated whether acupressure can enhance the effectiveness of lidocaine in reducing anxiety, stress, and pain among patients undergoing pleural puncture procedures. Therefore, this study aimed to evaluate the effectiveness of 2% lidocaine combined with acupressure in reducing anxiety, stress, and pain during pleural puncture procedures.

## SUBJECTS AND METHOD

### 1. Study Design

This study employed a quasi-experimental pretest-posttest design with three parallel groups. The study was conducted in the inpatient ward of the Department of Pulmonology and Respiratory Medicine, Dr. Moewardi General Hospital, Surakarta, Indonesia, from October to November 2025.

### 2. Population and Sample

The target population comprised patients undergoing pleural puncture (thoracentesis) at Dr. Moewardi Hospital, Surakarta, Indonesia. Participants were recruited using a consecutive sampling technique until the required sample size was achieved. A total of 36 participants were enrolled and assigned to one of three groups consisting of 12 participants each: (1) Control group receiving 2% lidocaine 4 cc, (2) Treatment group 1 receiving 2% lidocaine 4 cc combined with acupressure, and (3) Treatment group 2 receiving 2% lidocaine 2 cc combined with acupressure.

The minimum sample size was calculated using the Federer formula for experimental studies:

$$(t - 1)(n - 1) \geq 15$$

where t represents the number of treatment groups and n represents the number of subjects per group. Based on this formula, a minimum of nine participants per group was required. To increase statistical power and account for potential dropouts, 12 participants were included in each group, resulting in a total sample size of 36 participants.

### 3. Inclusion and Exclusion Criteria

The inclusion criteria were: (1) patients scheduled to undergo thoracentesis at Dr. Moewardi General Hospital; (2) aged 18 years or older; (3) fully conscious and oriented (compos mentis); (4) willing to participate and provide written informed consent; (5) able to communicate in Indonesian; (6) able to read and complete study questionnaires independently; and (7) hemodynamically stable. The exclusion criteria were: (1) use of short- or medium-acting systemic analgesics within 24 hours before the procedure; (2) use of long-acting analgesics within 72 hours before the procedure; (3) use of anti-anxiety medication within 24 hours before the procedure; (4) history of alcohol dependence or narcotic abuse; (5) known allergy to lidocaine; and (6) history of cardiac stent implantation.

**4. Study Variables**

The independent variable was the intervention administered during pleural puncture, consisting of three treatment modalities: 2% lidocaine 4 cc alone, 2% lidocaine 4 cc combined with acupressure, and 2% lidocaine 2 cc combined with acupressure. The dependent variables were anxiety level, stress level, and pain intensity measured before and after the procedure.

**5. Operational Definition of Variables**

**Anxiety and stress** were measured using the DASS-21 before and immediately after pleural puncture. Higher scores indicated greater anxiety and stress levels.

**Pain intensity** was assessed using the Numeric Rating Scale (NRS; 0–10) before and immediately after the procedure. Higher scores indicated greater pain intensity.

**Acupressure** was applied for 20 minutes before pleural puncture at the Neiguan (PC6), Yintang (EX-HN3), Hegu (LI4), and Baihui (GV20) acupoints. All procedures were performed according to standard hospital protocols.

**6. Data Analysis**

Data were analyzed using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA). Data normality was assessed using the Shapiro-Wilk test, while homogeneity of variance was evaluated using Levene's test. For normally distributed and homogeneous data, differences among groups were analyzed using one-way analysis of variance (ANOVA), followed by the Least Significant Difference (LSD) post hoc test for pairwise comparisons. Changes in anxiety, stress, and pain scores before and after intervention within each group were analyzed using paired t-tests. Statistical significance was set at $p < 0.05$.

**7. Research Ethics**

This study received ethical approval from the Health Research Ethics Committee of Dr. Moewardi General Hospital, Surakarta, Indonesia (No. 2.075/ IX/ HREC/ 2025). Written informed consent was obtained from all participants before enrollment. Participant confidentiality and anonymity were maintained throughout the study.

## RESULTS

A total of 36 patients were included in the study and equally allocated into three groups. Baseline demographic characteristics, including age, sex, occupation, and educational level, were compared across the control and treatment groups. The mean age ranged from 50.08 to 58.08 years. Male participants predominated in all groups, accounting for 50.0%–75.0% of subjects. Most participants had completed senior high school education, and the distribution of occupations was relatively similar among groups. Statistical analyses showed no significant differences in age, sex, occupation, or educational level among the three groups ($p > 0.05$), indicating that the groups were comparable at baseline and that demographic factors were unlikely to confound the intervention outcomes.

Table 1 shows that the demographic characteristics of participants were well balanced across groups. The absence of statistically significant differences in baseline variables supports the internal validity of the study and suggests that subsequent differrences in anxiety, stress, and pain outcomes were more likely attributable to the interventions rather than pre-existing demographic variations.

**Table 1. Subject Characteristics Across Treatment Groups**

| Characteristic | Control (n=12) | Treatment 1 (n=12) | Treatment 2 (n=12) | p |
|---|---|---|---|---|
| **Age** (years, mean; SD) | Mean= 50.08; SD= 9.14 | Mean= 51.67; SD= 11.01 | Mean= 58.08; SD= 14.27 | 0.221[a] |
| **Sex** | | | | |
| Male | 9 (75%) | 6 (50%) | 7 (58.3%) | 0.441[b] |
| Female | 3 (25%) | 6 (50%) | 5 (41.7%) | |
| **Occupation** | | | | |
| Unemployed | 2 (16.7%) | 1 (8.3%) | 1 (8.3%) | 0.987[b] |
| Farmer | 2 (16.7%) | 4 (33.3%) | 4 (33.3%) | |
| Laborer | 3 (25%) | 3 (25%) | 2 (16.7%) | |
| Civil servant | 2 (16.7%) | 2 (16.7%) | 2 (16.7%) | |
| Private employee | 3 (25%) | 2 (16.7%) | 3 (25%) | |
| **Education** | | | | |
| No schooling | 1 (8.3%) | 0 (0.0%) | 1 (8.3%) | 0.997[b] |
| Elementary | 1 (8.3%) | 2 (16.7%) | 1 (8.3%) | |
| Junior high | 2 (16.7%) | 2 (16.7%) | 2 (16.7%) | |
| Senior high | 4 (33.3%) | 5 (41.7%) | 4 (33.3%) | |
| Bachelor (S1) | 3 (25%) | 2 (16.7%) | 3 (25%) | |
| Masters (S2) | 1 (8.3%) | 1 (8.3%) | 1 (8.3%) | |

Notes: [a] ANOVA test; [b] Chi-square test

Changes in anxiety, stress, and pain scores before and after the intervention were analyzed within and between groups. Baseline anxiety, stress, and pain scores were comparable among the three groups, with no statistically significant differences observed (p>0.05). Following the intervention, all groups demonstrated significant improvements in the measured outcomes; however, participants receiving acupressure combined with lidocaine exhibited greater reductions than those receiving lidocaine alone.

As shown in Table 2, anxiety scores decreased significantly in all groups after the procedure. In the control group, anxiety scores decreased from (Mean = 10.50; SD = 3.08) to (Mean = 8.00; SD = 3.07; p < 0.001). In Treatment 1, anxiety scores decreased from (Mean = 10.50; SD = 3.20) to (Mean = 5.66; SD = 2.38; p < 0.001), while in Treatment 2 they decreased from (Mean = 10.33; SD = 2.53) to (Mean = 5.16; SD= 2.48; p < 0.001). Between-group analysis demonstrated significant differences in anxiety reduction (ANOVA p= 0.009). Post hoc analysis showed significantly greater reductions in both Treatment 1 (p = 0.012) and Treatment 2 (p= 0.005) compared with the control group, whereas no significant difference was observed between the two treatment groups (p=0.706).

A similar pattern was observed for stress scores. In the control group, stress scores decreased from (Mean=9.33; SD= 3.33) to (Mean=7.16; SD=3.01; p=0.003). In Treatment 1, stress scores decreased from (Mean=10.00; SD=3.90) to (Mean= 4.50; SD=2.27; p<0.001), while in Treatment 2 they decreased from (Mean=9.83; SD= 3.35) to (Mean=4.33; SD=2.53; p <0.001). Significant differences in stress reduction were observed among groups (ANOVA p=0.001). Post hoc analysis confirmed significantly greater reductions

in both treatment groups than in the control group (both p=0.001), while no significant difference was found between Treatment 1 and Treatment 2 (p=1.000).

Pain scores also decreased significantly following the intervention. In the control group, pain scores decreased from (Mean = 4.16; SD = 1.85) to (Mean = 2.91; SD = 1.67; p < 0.001). In Treatment 1, pain scores decreased from (Mean = 4.08; SD = 1.62) to (Mean= 1.50; SD= 1.31; p < 0.001), whereas in Treatment 2 they decreased from (Mean= 4.00; SD = 1.75) to (Mean = 1.33; SD= 0.88; p < 0.001). Between-group comparison showed significant differences in pain reduction (ANOVA p = 0.036). Post hoc analysis demonstrated significantly greater pain reduction in Treatment 1 (p = 0.029) and Treatment 2 (p= 0.021) compared with the control group. No significant difference was observed between the two treatment groups (p = 0.888).

Overall, the addition of acupressure to standard lidocaine administration resulted in significantly greater reductions in anxiety, stress, and pain during pleural puncture. Comparable outcomes between Treatment 1 and Treatment 2 indicate that reducing the lidocaine dose from 4 cc to 2 cc did not significantly affect the effectiveness of the intervention when acupressure was applied.

**Table 2. Anxiety, Stress, and Pain Scores Before and After Intervention with Post Hoc Analysis**

| Outcome | Group | Before (mean ± SD) | After (mean ± SD) | p (paired) | Δ (mean ± SD) | Post Hoc p-value |
|---|---|---|---|---|---|---|
| **Anxiety** | Control | 10.50 ± 3.08 | 8.00 ± 3.07 | <0.001 | −2.50 ± 1.73 | — |
| | Treatment 1 | 10.50 ± 3.20 | 5.66 ± 2.38 | <0.001 | −4.83 ± 2.75 | vs Control: 0.012 |
| | Treatment 2 | 10.33 ± 2.53 | 5.16 ± 2.48 | <0.001 | −5.16 ± 1.80 | vs Control: 0.005 |
| | p (ANOVA) | 0.987 | 0.031 | | 0.009 | T1 vs T2: 0.706 |
| **Stress** | Control | 9.33 ± 3.33 | 7.16 ± 3.01 | 0.003 | −2.16 ± 1.99 | — |
| | Treatment 1 | 10.00 ± 3.90 | 4.50 ± 2.27 | <0.001 | −5.50 ± 2.71 | vs Control: 0.001 |
| | Treatment 2 | 9.83 ± 3.35 | 4.33 ± 2.53 | <0.001 | −5.50 ± 2.27 | vs Control: 0.001 |
| | p (ANOVA) | 0.892 | 0.020 | | 0.001 | T1 vs T2: 1.000 |
| **Pain** | Control | 4.16 ± 1.85 | 2.91 ± 1.67 | <0.001 | −1.25 ± 0.86 | — |
| | Treatment 1 | 4.08 ± 1.62 | 1.50 ± 1.31 | <0.001 | −2.58 ± 1.44 | vs Control: 0.029 |
| | Treatment 2 | 4.00 ± 1.75 | 1.33 ± 0.88 | <0.001 | −2.66 ± 1.82 | vs Control: 0.021 |
| | p (ANOVA) | 0.973 | 0.012 | | 0.036 | T1 vs T2: 0.888 |

*Notes*: Paired t-test for within-group comparison; one-way ANOVA for between-group comparison; LSD post hoc test for pairwise differences. p < 0.05 = significant. Control = lidocaine 2% 4 cc only; Treatment 1 = lidocaine 2% 4 cc + acupressure; Treatment 2 = lidocaine 2% 2 cc + acupressure.

## DISCUSSION

This study demonstrated that the combination of 2% lidocaine and acupressure was associated with greater reductions in anxiety, stress, and pain among patients undergoing pleural puncture compared with lidocaine alone. In addition, reducing the lidocaine dose from 4 cc to 2 cc did not significantly alter the effectiveness of the intervention when acupressure was applied. These findings suggest that acupressure may serve as an effective complementary therapy for improving both psychological and physical comfort during pleural puncture procedures.

The present study found that patients receiving 2% lidocaine alone experienced significant reductions in anxiety, stress, and pain after the procedure. This finding is consistent with the established pharmacological mechanism of lidocaine, which blocks voltage-gated sodium channels and inhibits nociceptive signal transmission from peripheral tissues to the central nervous system (Halili et al., 2020; Silva et al., 2023).

Nevertheless, although pain scores decreased in the control group, anxiety levels remained relatively higher than those observed in the acupressure groups. This finding highlights the limitation of local anesthetic administration in addressing the psychological aspects of procedural discomfort. Previous evidence has shown that procedural anxiety may persist despite adequate analgesia and may independently influence pain perception and patient satisfaction (Du et al., 2023).

The greater improvement observed in the acupressure groups may be explained by several neurophysiological mechanisms. Acupressure has been reported to stimulate the release of endogenous opioids, including β-endorphins, enkephalins, and dynorphins, which contribute to pain modulation and relaxation responses (Liu et al., 2023). In addition, stimulation of the PC6 (Neiguan) acupoint has been associated with autonomic nervous system regulation and reductions in cortisol levels, resulting in decreased stress responses (Liu et al., 2023; Diyanto et al., 2023). The GV20 (Baihui) and EX-HN3 (Yintang) acupoints have traditionally been used to improve emotional balance and reduce anxiety, whereas LI4 (Hegu) is widely recognized for its analgesic properties through activation of descending inhibitory pain pathways (Focks, 2008; Kwon & Lee, 2018; Bastani et al., 2016). The combined stimulation of these acupoints may therefore provide synergistic effects on both emotional and physical dimensions of procedural discomfort.

The findings of the present study are consistent with previous studies evaluating acupressure in various clinical settings. Duzova et al. (2025) reported significant reductions in anxiety, depression, and pain among gynecological cancer patients undergoing brachytherapy who received acupressure. Similarly, Sharifi et al. (2017) demonstrated that acupressure significantly reduced pain and anxiety in patients undergoing bone marrow biopsy.

A systematic review by Alizadeh and Takasi (2024) further concluded that acupressure was effective in reducing anxiety and pain during cardiac catheterization procedures. Taken together, these findings support the growing evidence that acupressure can be used as a safe and effective non-pharmacological intervention to improve patient comfort during invasive medical procedures.

An important finding of this study was the absence of significant differences between patients receiving 2 cc and 4 cc of 2% lidocaine when both groups received acupressure. This observation suggests that

lower doses of lidocaine may provide sufficient analgesic effects when combined with acupressure. From a clinical perspective, this finding is relevant because lidocaine toxicity is dose-dependent, and minimizing anesthetic exposure may improve patient safety while maintaining procedural comfort (Silva et al., 2023). However, further studies with larger sample sizes are needed to confirm whether lidocaine dosage can be safely reduced in routine clinical practice when acupressure is incorporated.

The demographic characteristics of participants were relatively homogeneous across groups, indicating that baseline differences were unlikely to influence the study outcomes. The mean age ranged from 50 to 58 years, which is consistent with the age distribution commonly observed among patients with pleural effusion. Previous studies have reported that aging may alter pain perception and stress responsiveness through physiological changes in the nervous and endocrine systems (Zhi et al., 2024; Goncharova et al., 2023). Although the control group included a higher proportion of male participants, baseline anxiety, stress, and pain scores did not differ significantly among groups.

Therefore, the observed treatment effects are more likely attributable to the intervention rather than demographic differences. Nevertheless, sex-related variations in pain perception and stress responses should be considered in future investigations because biological and psychosocial factors may influence individual responses to both pharmacological and non-pharmacological interventions (Barcelon et al., 2023; Kudielka and Kirschbaum, 2005).

Overall, the findings of this study suggest that acupressure may serve as a valuable adjunct to standard local anesthesia during pleural puncture procedures. By addressing both psychological distress and physical pain, acupressure has the potential to enhance patient-centered care and improve the overall procedural experience. Further multicenter studies involving larger and more diverse populations are warranted to confirm these findings and explore the long-term benefits of integrating acupressure into routine thoracentesis practice.

This study has several limitations. First, no objective biomarkers (e.g., cortisol, heart rate variability) were measured to corroborate the self-reported outcomes. Second, variability in skin thickness and lidocaine infiltration technique was not standardized, which may have influenced anesthetic diffusion and efficacy. Third, the sample size was relatively small (n=12 per group), limiting generalizability.

Finally, the absence of prior studies specifically examining acupressure in thoracentesis restricts external benchmarking. Future studies should incorporate objective physiological measures, standardized anesthetic technique, larger samples, and explore additional acupoints such as HT7 (Shenmen) and ST36 (Zusanli).

The combination of 2% lidocaine with acupressure is effective in reducing anxiety, stress, and pain in patients undergoing pleural puncture. Both lidocaine 2 cc and 4 cc combined with acupressure produced equivalent and significantly superior outcomes compared to lidocaine alone, indicating that increasing the lidocaine dose beyond 2 cc provides no additional benefit when acupressure is administered. Acupressure represents a safe, accessible, and cost-effective non-pharmacological adjunct that may be integrated into standard procedural care protocols for thoracentesis, provided healthcare personnel receive adequate competency training.

## AUTHORS' CONTRIBUTIONS

All authors contributed substantially to the conception and design of the study, data collection, data analysis and interpretation, manuscript drafting, critical revision of the manuscript, and approval of the final version for publication.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest relevant to this study.

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