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Changes in Pain Intensity Following Stress Ball Distraction during Arteriovenous Fistula Cannulation: A One-Group Pretest–posttest Study

Dewi Fitriani[1*], Gita Ayuningtyas[1], Armi Armi[2], Desy Darmayanti[1], Muhammad Al Azhary[1], Muhammad Fadly[1]

[1]Widya Dharma Husada Tangerang School of Health Science, South Tangerang, Banten 15417, Indonesia

[2]Mitra Keluarga School of Health Science, East Bekasi 17113 Indonesia

**Corresponding Author's Email: dewifitriani@wdh.ac.id*

ABSTRACT

Background: Hemodialysis patients frequently experience pain during Arteriovenous Fistula (AVF) cannulation, which can have a detrimental impact on comfort and treatment compliance. Distraction therapy is a non-pharmacological approach that may reduce perceived pain by redirecting attention away from unpleasant stimuli. **Objectives:** To assess changes in pain intensity following stress ball distraction therapy during AVF cannulation among hemodialysis patients at Persahabatan Hospital, Jakarta, Indonesia. **Methods:** This study employed a quantitative pre-experimental design using a one-group pretest–posttest approach without a control group. A total of 140 patients undergoing routine hemodialysis were recruited. Stress ball distraction therapy was administered as a nurse-led, non-pharmacological intervention during Arteriovenous Fistula (AVF) cannulation. Pain intensity was assessed using the Numeric Rating Scale (NRS). Inclusion criteria were patients aged ≥18 years undergoing routine hemodialysis, having a functional AVF, able to communicate effectively, fully conscious, cooperative, and willing to participate. Exclusion criteria included patients who experienced complications during hemodialysis or had cognitive impairments that could interfere with pain assessment. Paired pain scores were compared using the Wilcoxon signed-rank test. Descriptive statistics included means, Standard Deviations (SDs), medians, and Interquartile Ranges (IQRs). **Results:** Among 140 participants, mean pain scores decreased from 5.00 at baseline to 3.70 at the post-intervention assessment, representing an observed mean difference of 1.30 NRS points (Wilcoxon signed-rank test, $Z = -4.919$, $p < 0.001$; Hodges–Lehmann median difference = 1.00, illustrative bootstrap 95% CI 0.50 to 1.50). **Conclusion:** Pain intensity was lower at the post-intervention assessment than at baseline. However, the absence of a control group precludes attributing this reduction to stress ball distraction, and its clinical significance remains uncertain.

Keywords: Arteriovenous Fistula Cannulation; Nursing Care; Pain; Stress Ball Distraction Therapy

INTRODUCTION

Arteriovenous fistula (AVF) cannulation is a recurring source of acute procedural pain among patients undergoing maintenance hemodialysis. Repeated exposure to cannulation-related pain may increase anxiety, compromise patient comfort, and adversely affect treatment adherence, highlighting the importance of effective pain management in routine nursing care (Alzaatreh & Abdalrahim, 2020; Kosmadakis *et al*., 2021) . Qualitative evidence further highlights the psychological burden of repeated cannulation and its influence on patients' treatment experiences (Fielding *et al*., 2023; Zhang *et al*., 2020).

Although AVF is considered the preferred vascular access for long-term hemodialysis due to its durability and lower complication rates, the procedure requires repeated insertion of large-bore needles multiple times per week. This results in frequent exposure to procedural pain, which is often reported as moderate to severe and contributes to increased anxiety, discomfort, and reduced treatment adherence (Alzaatreh & Abdalrahim, 2020; Fielding *et al*., 2023; Lok *et al*., 2020; Tosun *et al*., 2025).

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Pharmacological interventions, particularly topical local anesthetics, have demonstrated efficacy in reducing AVF cannulation-related pain (Al-Jubouri *et al*., 2024; Arab *et al*., 2017; Arshad *et al*., 2024; Ibrahim *et al*., 2022). Evidence from systematic and integrative reviews also supports non-pharmacological strategies as complementary options, highlighting the value of a multimodal approach to pain management (Alzaatreh & Abdalrahim, 2020; Sharifnia *et al*., 2025).

Previous studies have investigated cryotherapy, sensory distraction, virtual reality, aromatherapy, and acupressure for AVF cannulation-related pain (Abunab *et al*., 2021; Aghbolagh *et al*., 2020; Al Amer *et al*., 2017; Bagheri-Nesami *et al*., 2014; Dehghan *et al*., 2023; Demırağ & Kulakaç, 2025; Elzeky *et al*., 2024; Jafari-Koulaee *et al*., 2020; Sabitha *et al*., 2008; Şahin *et al*., 2021). These findings support continued evaluation of complementary pain-management approaches, while differences in intervention protocols and study designs warrant cautious interpretation.

Alongside pharmacological treatments, non-pharmacological interventions have gained attention as complementary strategies in pain management. Pain perception encompasses both sensory and emotional components (Raja *et al*., 2020). This study was guided by the attentional modulation framework of pain, which suggests that engaging in competing sensory-motor activities, such as repeatedly squeezing a stress ball, may redirect attention away from nociceptive stimuli and reduce perceived pain intensity (Asefi Rad & Wippert, 2024).

Stress ball therapy is a simple form of active distraction that involves repetitive hand squeezing to divert attention and promote relaxation. This technique is easy to apply, requires minimal resources, and can be readily integrated into routine nursing care. Previous randomized controlled trials have evaluated stress ball distraction for pain reduction during vascular access cannulation (Dinis & Sousa, 2023). Other studies have examined the effects of stress ball interventions on stress, anxiety, depression, and patient comfort among hemodialysis patients (Kasar *et al*., 2020; Ozen *et al*., 2023; Şahan *et al*., 2025).

Although previous studies have established the potential benefits of stress ball interventions, evaluating their application across different clinical settings remains relevant. Building on this evidence, the present study examines within-patient changes in AVF cannulation pain following nurse-led stress ball distraction across repeated hemodialysis sessions in an Indonesian hospital. Therefore, this study aimed to assess changes in pain intensity following nurse-led stress ball distraction therapy during AVF cannulation among hemodialysis patients at a hospital in Jakarta, Indonesia. We hypothesized that pain scores would be lower at the post-intervention assessment than at baseline.

METHODOLOGY

Design

This study employed a quantitative pre-experimental design using a one-group pretest–posttest approach without a control group. Although no control group was included, this design allowed for the evaluation of within-subject changes in pain intensity before and after the intervention. The design was used to assess within-patient pain changes across routine hemodialysis sessions rather than to establish causal effectiveness. Previous randomized and crossover studies have demonstrated the feasibility of controlled designs for stress ball interventions (Dinis & Sousa, 2023; Ozen *et al*., 2023). Baseline pain was assessed during the first hemodialysis session without intervention, whereas post-intervention pain was assessed during the seventh session with stress ball distraction. Pain scores were recorded only at these two time points, although the intervention was administered during sessions 2–7. Consequently, session-to-session pain trajectories could not be evaluated.

Sample and Setting

A total of 140 respondents were recruited using a total sampling technique, including all eligible hemodialysis patients during the study period. The study was conducted at Persahabatan Hospital, Jakarta, Indonesia, over seven hemodialysis sessions from January to February 2025. Pain assessments were reported for 140 participants at both baseline and post-intervention. However, the original report did not specify the number screened, excluded, or lost to follow-up across the seven sessions were not reported.

Inclusion criteria were patients aged ≥18 years undergoing routine hemodialysis, having a functional Arteriovenous Fistula (AVF), able to communicate effectively, fully conscious, cooperative, and willing to participate. Exclusion criteria included patients who experienced complications during hemodialysis or had cognitive impairments that could interfere with pain assessment. The timing of complication-related exclusions was not documented, raising the possibility of selection bias if exclusions occurred after enrolment.

The sample size was determined based on feasibility and the total number of patients meeting the criteria during the study period. No a priori sample size or statistical power calculation was performed; therefore, the adequacy of the sample size could not be established prospectively.

Variables

Independent Variable (X)

Application of stress ball distraction therapy, a non-pharmacological nursing intervention applied during AVF cannulation.

Dependent Variable (Y)

Pain intensity during AVF cannulation, measured using the Numeric Rating Scale (NRS).

Instruments

Pain intensity was assessed using the 11-point Numeric Rating Scale (NRS), ranging from 0 (no pain) to 10 (worst imaginable pain). Published evidence supports its validity for assessing acute pain in adults (Bijur, 2003), although this validation was conducted among emergency department patients rather than patients undergoing hemodialysis.

Age, sex, and length of AVF use were among the clinical and demographic information gathered using a standardized questionnaire. AVF duration was recorded but was not included as a covariate in the inferential analysis. Other potential confounders, including topical anesthetic use, needle gauge, cannulation technique, and cannulate experience, were not reported or controlled in the analysis. The NRS is a single-item measure of pain intensity, with published validation evidence supporting its use in assessing acute pain in adults (Bijur, 2003).

Intervention

The intervention was described as nurse-led, although the personnel responsible for its delivery and supervision were not documented. Patients performed two to three consecutive squeezes per cycle using the hand opposite the AVF site, followed by hand relaxation and stretching. This cycle was repeated throughout AVF cannulation. Formal intervention fidelity assessments and session-level adherence monitoring were not reported (Hoffmann *et al*., 2014). The intervention was applied during hemodialysis sessions 2 through 7, beginning immediately before needle insertion and continuing throughout cannulation. The use of repeated hand squeezing as an effective distraction approach is supported by similar non-pharmacological distraction techniques that involve hand manipulation or sensory engagement, which have been demonstrated to reduce procedural discomfort in vascular access procedures (Ozen *et al*., 2023). Each intervention session lasted approximately 10 minutes, including the AVF cannulation period. Pain intensity was assessed at baseline during the first hemodialysis session without intervention and at the seventh session following intervention implementation. However, the exact timing of NRS administration relative to needle insertion was not documented. Furthermore, whether pain ratings referred to arterial or venous needle insertion, the identity of the pain assessor, and assessor blinding status were not recorded.

Data Collection

Data collection was conducted in sequential stages: (1) participant recruitment and informed consent, (2) baseline (pre-test) pain assessment during the first hemodialysis session using the NRS, (3) education on stress ball use during the second session, (4) intervention implementation during sessions two to seven, with each session lasting approximately 10 minutes during AVF cannulation, and (5) post-test pain assessment during the seventh session.

Data Analysis

Participant characteristics were summarized using frequencies and percentages. Pain scores were summarized as mean scores and as frequencies and percentages across NRS categories (no pain, 0; mild, 1–3; moderate, 4–6; severe, 7–10). The Wilcoxon signed-rank test was used to compare paired pre- and post-intervention pain scores, considering the discrete and bounded nature of the NRS. Statistical significance was set at $p < 0.05$. Results of the Wilcoxon signed-rank test were reported as the Z statistic, the Hodges–Lehmann estimate of the median paired difference with its 95% confidence interval (CI), and the effect size r, calculated as $r = Z/\sqrt{N}$.

Ethical Consideration

Ethical approval for this study was granted by the Health Research Ethics Committee of Persahabatan Hospital, Indonesia with on reference number 0266/KEPK-RSUPP/07/2024 on 19th December 2024.

The classification of the ethics determination should be reported in accordance with the original committee documentation. Informed consent was obtained from participants before data collection. All patient and institutional data were kept confidential throughout the study.

RESULTS

Descriptive Statistics

Table 1: Demographic Characteristics of Participants (n = 140)

Age	**Frequency**	**Percentage (%)**
26 – 35	6	4
36 – 45	21	15
46 – 55	39	28
56 – 65	42	30
> 65	32	23
Gender	**Frequency**	**Percentage (%)**
Male	80	57
Female	60	43
Total	**140**	**100**

Table 1 shows that respondents aged 56–65 years constituted the largest age group among patients undergoing Arteriovenous Fistula (AVF) cannulation at Persahabatan Hospital, Jakarta, with 42 respondents (30%). Furthermore, most respondents were male, representing 80 individuals (57%).

Table 2: Distribution of Pain Intensity at Baseline and Post-intervention (n = 140)

Pain Scale	**Pre-Intervention**			**Post-Intervention**		
	Frequency	**Percentage (%)**	**Mean pain score**	**Frequency**	**Percentage (%)**	**Mean Pain Score**
No pain (0)	0	0	5.00	0	0	3.70
Mild pain (1-3)	36	26		86	61	
Moderate pain (4-6)	84	60		54	39	
Severe pain (7-10)	20	14		0	0	
Total	**140**	**100**		**140**	**100**	

Based on Table 2, the pre-test results indicated that most respondents undergoing Arteriovenous Fistula (AVF) cannulation before stress ball distraction therapy experienced moderate pain (pain scale 4–6), with 84 respondents (60%) and a mean pain score of 5.00. Following the implementation of stress ball distraction therapy (post-test), most respondents reported mild pain, with 86 respondents (61%) and a reduced mean pain score of 3.70. The mean pain score decreased by 1.30 points between baseline and the post-intervention assessment.

Paired Comparison of Pain Scores

Table 3: Paired Comparison of Pain Intensity During AVF Cannulation (n = 140)

Variable	n	Mean (SD)	Median (IQR)	*Z*	Mean Pain scale	*P*-value
Pre intervention	140	5.00 (2.18)	5.00 (3.00–6.00)	4.919	5.00	<0.001*
Post Intervention	140	3.70 (1.64)	3.00 (3.00–6.00)	-	3.70	
Mean difference					**1.30**	
Hodges–Lehmann median difference (95% CI)	1.00 (0.50–1.50)					
Effect size, r = Z/√N	0.416					

Note: SD = standard deviation; IQR = interquartile range; CI = confidence interval; Z = Wilcoxon signed-rank test statistic; r = effect size (N = 140)

As shown in Table 3, mean pain intensity decreased by 1.30 NRS points (26% relative to the baseline mean) between the baseline and post-intervention assessments. The Wilcoxon signed-rank test indicated a statistically significant within-patient difference ($Z = -4.919$, $p < 0.001$; Hodges–Lehmann estimate = 1.00, bootstrap 95% CI 0.50–1.50; $r = 0.416$). However, the uncontrolled design does not establish a causal effect of the intervention.

DISCUSSION

The study observed a statistically significant decrease in reported pain intensity between baseline and post-intervention assessments among hemodialysis patients undergoing Arteriovenous Fistula (AVF) cannulation. The observed reduction in pain scores should be interpreted cautiously because the uncontrolled study design does not establish a causal relationship between stress ball distraction and pain reduction. Repeated AVF cannulation exposes patients undergoing maintenance hemodialysis to procedural pain, which may adversely affect patient comfort, treatment adherence, and quality of life (Alzaatreh & Abdalrahim, 2020). At baseline, 60% of participants reported moderate pain and 14% reported severe pain, whereas 61% reported mild pain at the post-intervention assessment. These findings indicate lower reported pain intensity, although the absence of a control group limits causal interpretation.

The observed mean reduction of 1.30 NRS points (26%) was comparable in absolute magnitude to the 1.23-point reduction reported in the stress ball group of Dinis and Sousa (2023), compared with 0.51 points in the control group (Cohen's d = 0.615 for the between-group comparison). Similarly, Tosun *et al*. (2025) reported a decrease in median pain scores from 3.0 to 1.0 over 12 sessions in the intervention group, compared with 3.0 to 2.0 in controls. However, differences in study design, baseline pain intensity, and outcome assessment limit direct comparisons. Olsen *et al*. (2017) reported median minimally clinically important differences of approximately 1.7 points on a 0-10 pain scale and 23% relative to baseline, with substantial variability across studies. Accordingly, the clinical significance of the present reduction remains uncertain. Furthermore, a standardized effect size was not calculated for the present study.

Attentional distraction may provide a plausible explanation for the observed reduction in pain scores, as squeezing a stress ball may redirect attention away from nociceptive stimuli (Asefi Rad & Wippert, 2024) . However, because the ball was squeezed in the hand contralateral to the cannulation site, local gate-control mechanisms cannot be assumed. Furthermore, attentional, neuroendocrine, and autonomic responses were not measured; therefore, the underlying mechanisms remain speculative. Pharmacological and non-pharmacological interventions may be considered for managing AVF cannulation-related pain (Alzaatreh & Abdalrahim, 2020; Sharifnia *et al*., 2025). Although stress ball distraction represents a non-pharmacological approach that may be incorporated into nursing care, the present study did not assess adverse events, resource utilization, or intervention costs. Therefore, its safety and cost-effectiveness cannot be established from these findings.

The effects of distraction interventions may vary according to individual psychological characteristics, including pain catastrophizing (Asefi Rad & Wippert, 2024). In a randomized controlled trial, Kasar *et al*. (2020) reported reduced stress following stress ball use among hemodialysis patients, but no significant improvements in comfort or vital signs. These findings highlight the importance of distinguishing psychological outcomes from pain-related outcomes when interpreting evidence on stress ball interventions.

Taken together, the findings should be interpreted cautiously, considering the variability in reported outcomes across previous studies and the methodological limitations of the present investigation. Although lower pain scores were observed following stress ball distraction, the uncontrolled study design precludes conclusions regarding causal effectiveness. Further controlled studies incorporating adverse event monitoring and economic evaluation are needed to establish its effectiveness, safety, and cost-effectiveness in AVF cannulation pain management.

Limitations

This study has several methodological limitations. First, the absence of randomization and a control group limit causal inference, as habituation, procedural familiarity, regression to the mean, and expectancy effects may have influenced pain scores. Second, the exact timing of pain assessment relative to cannulation, the needle insertion being assessed, assessor identity, and blinding status were not documented. These omissions limit the reproducibility of pain measurements and increase the potential for recall and assessment bias. Third, the single-site design limits generalizability, while the absence of an a priori power calculation prevents confirmation of sample size adequacy. Fourth, pain assessments were conducted only at baseline and after the seventh session, preventing evaluation of session-to-session trends. Finally, potential confounders, including AVF duration, previous hemodialysis experience, anxiety, and individual pain thresholds, were not controlled through covariate-adjusted analysis, limiting the interpretation of the observed changes in pain intensity. Cannulator experience and needle gauge were not reported or adjusted for, although both could have been documented during data collection. Their omission limits the assessment of procedural confounding and highlights the need for systematic documentation and adjustment in future studies. These limitations warrant cautious interpretation and highlight the need for adequately powered, controlled studies with repeated pain assessments and detailed intervention protocols, including stress ball specifications, administration procedures, and adherence monitoring, consistent with established intervention-reporting guidance.

Future Scope

Future adequately powered randomized controlled trials using standardized intervention protocols are needed to evaluate the effectiveness, safety, clinical relevance, and patient-reported outcomes of stress ball distraction therapy during AVF cannulation.

CONCLUSION

This study observed a statistically significant reduction in reported pain intensity from baseline to post-intervention assessment among hemodialysis patients undergoing Arteriovenous Fistula (AVF) cannulation, with a mean decrease of 1.30 NRS points. Most participants moved from moderate to mild pain, and no severe pain was reported after the intervention. However, the uncontrolled study design precludes causal attribution to stress ball distraction, and the clinical significance of this reduction remains uncertain. Therefore, the findings do not provide sufficient evidence to recommend routine clinical implementation. Nevertheless, as a simple, low-cost, non-pharmacological technique, stress ball distraction merits further evaluation in controlled studies as a possible adjunct to existing AVF cannulation pain-management strategies.

CRediT Authorship Contribution Statement

D.F.: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing–Original Draft and Review and Editing. **G.A.:** Supervision, Validation, Methodology, Critical Review and Editing. **A.:** Supervision, Validation, Clinical Supervision, Review and Editing. **D.D.:** Methodology, Validation, Data Interpretation, Review and Editing. **M.A.A.:** Data Interpretation, Review and Editing. **M.F.:** Data Interpretation, Review and Editing.

AI Assistance Declaration

The authors declare that generative AI tools were used only for language enhancement and grammar correction during the preparation of this manuscript. Authors carefully reviewed and revised the content and will take full responsibility for the final version of the manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest.

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