



COMPARISON OF PAIN AND COMFORT SCORES IN PATIENTS WITH CLOSED EXTREMITY FRACTURES WHO RECEIVED DOUBLE-SIDED AND TRIPLE-SIDED SPLINTS IN THE EMERGENCY DEPARTMENT OF A HOSPITAL

Ari Wibowo^{1,2*}, Masfuri¹, Liya Arista¹, Chiyar Edison¹, Tatang Sutisna¹

¹Medical Surgical Nursing Department, Faculty of Nursing, Universitas Indonesia, Jl. Prof. DR. Sudjono D. Pusponogoro, Pondok Cina, Kecamatan Beji, Kota Depok, Jawa Barat 16424, Indonesia

²Emergency Department, Soeradji Tirtonegoro Hospital, Jalan KRT Jl. Dr. Soeradji Tirtonegoro No.1, Dusun 1, Tegalyoso, Klaten Selatan, Klaten, Jawa Tengah 57424, Indonesia

*ari.wibowo43@ui.ac.id

ABSTRACT

Two-sided splinting (two-sided trauma to splinting) provides good stabilization of musculoskeletal fractures, commonly used in the form of a Rigid Board-splint, while 3-sided splinting provides stability that limits multidirectional movements. This study was to analyze the comparison of pain and comfort scores in two-sided splinting and three-sided splinting. This type of research is a Quasi-experimental study with a pre- and post-test nonequivalent control group. The study was conducted in the hospital's emergency room from January to April 2026. The sampling technique used was non-probability sampling in the form of convenience sampling. The researcher calculated the sample size using the G*Power program. The study sample was 52 divided into 2 groups. Data were collected using a questionnaire containing respondent characteristics, a VAS pain questionnaire, and a VAS comfort questionnaire. The data were analyzed univariately using descriptive statistics and bivariate tests to measure before and after the intervention in both the control and treatment groups. Two-sided and three-sided splinting had the same effect on reducing pain in patients with extremity fractures ($p < 0.001$). Two-sided and three-sided splinting had the same significant effect on increasing comfort in patients with extremity fractures ($p < 0.001$). Three-sided splinting significantly reduced pain scores and significantly increased comfort scores compared to two-sided splinting in patients with extremity fractures ($p < 0.001$). Three-sided splinting provides better stability support, thus limiting multidirectional movements, which is more effective in reducing pain, thus helping to reduce muscle spasms and tissue pressure, so that patients feel more comfortable.

Keywords: comfort; fracture; musculoskeletal; pain score; splinting

How to cite (in APA style)

Wibowo, A., Masfuri, M., Arista, L., Edison, C., & Sutisna, T. (2026). Comparison of Pain and Comfort Scores in Patients with Closed Extremity Fractures Who Received Double-Sided and Triple-Sided Splints in the Emergency Department of a Hospital. *Indonesian Journal of Global Health Research*, 8(5), 1087–1098. <https://doi.org/10.37287/ijghr.v8i5.2450>.

INTRODUCTION

Lower extremity fractures in hospital emergency departments (EDs) are the most common type of musculoskeletal injury resulting from high-energy trauma such as traffic accidents, falls, or sports injuries (Ferdianto & Prastawa, 2023). Extremity fractures account for a significant proportion of orthopedic trauma cases requiring immediate emergency care. According to the 2018 Basic Health Research (Riskesdas) report, the prevalence of accident-related injuries in Indonesia has reached a significant level, with young people being the most vulnerable group (Ministry of Health of the Republic of Indonesia, 2019). This is further supported by data from the Central Statistics Agency (BPS), which recorded an increase in traffic accidents to 103,645 incidents in 2021, of which 5.8% resulted in fractures, with the most common location being the lower extremities (Ferdianto & Prastawa, 2023; Geu et al., 2024). Other studies consistently show that lower extremity fractures, such as femur fractures, dominate cases treated in hospitals, even reaching around 39% of all admitted fracture cases (Faidah & Alvita, 2022).

Epidemiological reports in Indonesia often highlight lower extremity fractures as the dominant cases treated in referral hospitals (Sananta et al., 2022), upper extremity fractures (EEF) are a public health problem with a significant morbidity burden and an increasing trend in various regions. Globally, AEFs contribute to a massive incidence rate. For example, a comprehensive epidemiological study recorded more than 11.1 million new AEFs cases in China in 2021, indicating a steadily increasing disease burden and underscoring the urgency of effective treatment for this type of fracture (Martin et al., 2025). Citing the study's results, the number of new cases of upper extremity fractures increased by 31.92% from 1990 to 2021. Even the Age-Standardized Incidence Rate (ASIR) for radius and/or ulna (forearm) fractures, one of the main focus of the inclusion criteria in this study, reached 404.52 per 100,000 population in 2021 (Martin et al., 2025). Effective immobilization of fractures is crucial and serves as a primary protective intervention: (1) to prevent secondary injury to sensitive neurovascular structures, soft tissues, and muscles; (2) to reduce the risk of neurogenic shock due to severe, uncontrolled pain; and most crucially, (3) to significantly reduce pain by stopping the movement of bone fragments that are the source of nociceptive stimulation (Tosun et al., 2018). Pain in fractures is very intense, often reported with a score of $> 7/10$ on a pain scale caused by a combination of tissue damage, trauma to the receptor-rich periosteum, and movement of bone fragments (Andri et al., 2021). The continuous movement of the fragments irritates the nerve fibers and triggers a severe local inflammatory response. In addition, muscle spasms that function as the body's protective mechanism actually worsen the pain by pulling the fracture fragments in opposite directions, creating a continuous cycle of pain (Indrawan & Hikmawati, 2021). In clinical practice, there are various splinting techniques used for extremity fractures which are mainly distinguished based on the area of immobilization and the number of support sides applied to the injured extremity (Bayusentono et al., 2021). These variations reflect clinicians' efforts to achieve effective immobilization, although their comparative effectiveness remains a matter of debate that requires solid scientific evidence. The two main categories frequently used are bilateral splinting and three-sided splinting. Three - sided splinting : this technique is designed to provide the most rigid immobilization, often using a cast or splint that comprehensively wraps three sides of the limb (Geu et al., 2024).

Two - sided splinting : a combination of anterior and posterior splints (Faidah & Alvita, 2022). Two-sided splinting is popular due to its relative ease of application, but support in only two planes can be considered less than optimal in resisting torsional forces or small displacements. Although the differences in mechanical stability between these two techniques are clear theoretically, practice in the emergency department often shows significant variation in the choice of splint type (two-sided or three-sided) used (Prasetyani et al., 2025). These variations are based on material availability, institutional practices, or individual nurse preferences, and are not yet supported by robust comparative data on pain reduction outcomes in patients. Given the pressing clinical challenges, variations in practice, and fundamental scientific gaps, where previous studies have generally focused on comparing two groups of splint configurations limited to the lower extremities, this study is proposed to be one of the first to simultaneously test and compare the effectiveness of both configurations (bilateral and trilateral splints) on primary outcomes, namely pain scores and comfort in patients with extremity fractures. The novelty of this study will provide more comprehensive comparative evidence.

METHOD

This study used a quasi-experimental design with a pre- and post-test nonequivalent control group. The study was conducted at one of the vertical and referral hospitals in Central Java province, located in Klaten Regency. This study was conducted in January - April 2026. Inclusion criteria are Patients aged ≥ 18 years, Undergoing splinting immobilization, Level of consciousness compos mentis, There is a closed fracture of the lower arm or lower leg, Willing to be a research respondent. Exclusion criteria are Peripheral Vascular Disorders: Having a history of blood vessel blockage (such as PAD or Buerger's disease) that can interfere with the results of the CRT

examination naturally , Neuropathy patients , severe diabetes mellitus or peripheral nerve disorders and Multiple trauma. Respondents who Drop out are Patients who decide to stop being respondents during the study . The number of samples was determined by G-power. The sampling technique used was non-probability sampling in the form of convenience sampling. The number of respondents recruited in this study was 52 participants allocated with a 1: 1 ratio in the intervention group and the control group, each with 26 respondents. Data were collected using a VAS pain questionnaire sheet and a VAS Comfort questionnaire. Validity and reliability with interrater reliability in 10 participants were calculated using the Intraclass Correlation Coefficient (ICC) an ICC value of 0.993 (>0.90) with a p value <0.001 (p <0.05). Data analysis began with normality, homogeneity, univariate and baseline equality tests followed by bivariate tests with paired t-test and independent sample t-test, bivariate tests of confounding variables with Pearson , Mann-Whitney and Kruskal-Wallis. This research has passed the Ethics from KEPK Universitas 'Aisyiyah Surakarta Indonesia with Number. 818/I/AUEC/2026.

RESULT

Characteristics of Respondents based on Age and Time from trauma to splinting

Table 1

Characteristics based on age and time from trauma to splinting (n=52)

Variable	Group	n	Mean±SD	Min.-Max.	95% CI
Age	Intervention	26	39.19±16.77	18-78	32.41-45.96
	Control	26	43.81±15.33	19-80	37.61-50.00
Time from trauma to bidding	Intervention	26	66.57±31.07	30-120	54.03-79.13
	Control	26	58.34±19.34	30-102	20.53-66.16

Based on table 1 shows that the intervention group had a mean age of 39.19 years with a standard deviation of 16.77 years. The interval estimation results can be 95% confident that the mean age of respondents in the intervention group was in the range of 32.41 to 45.96 years in the population. Meanwhile, in the control group, the mean age of respondents was 43.81 years with a standard deviation of 15.33 years. The interval estimation results can be 95% confident that the mean age of respondents in the control group was in the range of 37.61 to 50.00 years.

Characteristics based on Gender, Analgesics, Fracture Location, Fracture Type

Table 2 Respondent Characteristics (n=52)

Variables	Category	Intervention		Control		Total	
		n	%	n	%	n	%
Gender	Man	16	61.5	15	57.7	31	59.6
	Woman	10	38.5	11	42.3	21	40.4
Analgesic	Yes	15	57.7	15	57.7	30	57.7
	No	11	42.3	11	42.3	22	42.3
Fracture location	Upper extremities	11	42.3	11	42.3	22	42.3
	Lower extremities	15	57.7	15	57.7	30	57.7
Fracture type	Transversal	15	57,7	8	30,8	23	44,3
	Oblique	4	15,4	11	42,3	15	28,8
	Komunitif	7	26,9	7	26,9	14	26,9

Based on table 2 explained that the majority of respondents' gender in this study were male, 31 (59.6%) patients, and female, 21 (40.4%) patients. The distribution of analgesic use in this study was dominated by participants who received analgesics, 30 (57.7 %) patients, then did not receive analgesics, 22 (42.3%) patients. The location of the fracture in this study was dominated by lower extremity fracture participants, namely 30 (57.7 %) patients, then upper extremity fractures, 22 (42.3%) patients. Meanwhile, based on the type of fracture, it was divided into transverse fractures, 23 respondents (44.3 %), oblique fractures, 15 (28.8%) respondents, and comminuted fractures, 14 (26.9%) respondents.

Respondents' pain scores and comfort scores

Table 3.

Analysis of equality of pain scores before and after splinting (n=52)

Analysis of equality of pain scores before and after spinning (n=52)						
Variables	Group	Measurement	n	mean $\pm$ SD	Median	Min.-Max.
<i>Pretest (n=52, p = 0.468*)</i>						
Pain Score	Pre-test	Intervention	26	62.3 $\pm$ 12.3	63.5	42.0-80.0
		Control	26	62.3 $\pm$ 11.5	66.0	40.0-80.0
	Post-test	Intervention	26	42.0 $\pm$ 12.9	43.0	17.0-65.0
		Control	26	55.2 $\pm$ 11.8	58.5	31.0-72.0
<i>Pretest (n=52, p = 0.501*)</i>						
Comfort	Pre-test	Intervention	26	37.2 $\pm$ 14.4	36.0	14.0-64.0
		Control	26	36.7 $\pm$ 12.7	33.5	18.0-65.0
	Post-test	Intervention	26	61.8 $\pm$ 14.3	65.5	31.0-82.0
		Control	26	43.9 $\pm$ 10.4	44.0	25.0-62.0

* Significant at $\alpha=0.05$ with Levene 's Test

The difference between pain and comfort scores in each group can be seen in the following image:

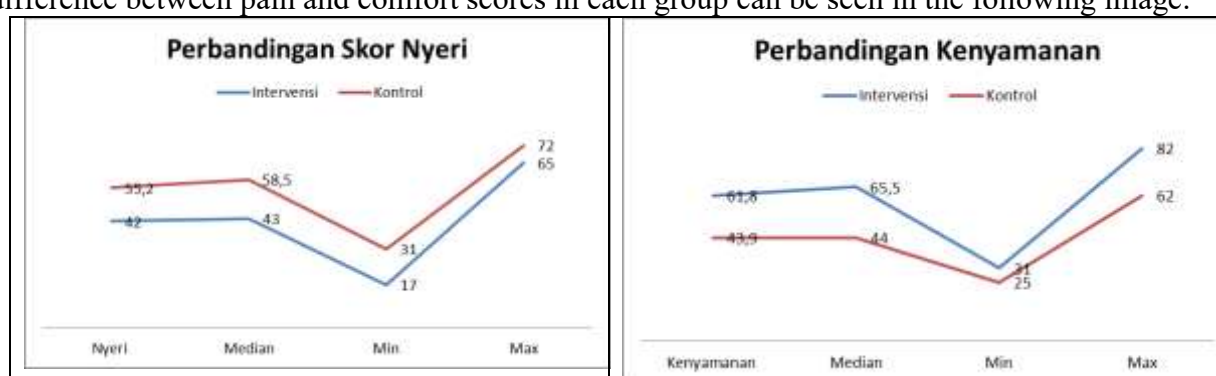


Figure 1. Pain and comfort scores in the intervention and control groups

The effect of 2-sided and 3-sided splinting on pain and comfort scores

Table 4.

Effect of splinting on pain and comfort (n=52)

Variables	Group	Measurement	Mean $\pm$ SD	t	p-value
Pain Score	Intervention	Pre-test	62,3 $\pm$ 12,3	28,572	< 0,001* ¹
		Post-test	42,0 $\pm$ 12,9		
	Kontrol	Pre-test	62,3 $\pm$ 11,6	22,565	< 0,001* ¹
		Post-test	55,2 $\pm$ 11,8		
	Intervensi Kontrol	Post-test	42,0 $\pm$ 12,9 55,2 $\pm$ 11,8	5,129	< 0,001* ²
	Intervensi Kontrol	Selisih (pre-post)	20,27 $\pm$ 3,61 7,19 $\pm$ 1,63	16,814	< 0,001* ²
Kenyan	Intervention	Pre-test	37.2 $\pm$ 14.4	-11,561	< 0.001* ¹
		Post-test	61.8 $\pm$ 14.3		
	Control	Pre-test	36.7 $\pm$ 12.7	-5.663	< 0.001* ¹
		Post-test	43.9 $\pm$ 10.4		
	Intervention Kontrol	Post-test	61.8 $\pm$ 14.3 43.9 $\pm$ 10.4	-3.83	< 0.001* ²
	Intervention Kontrol	This is true. (pre-post)	24.5 $\pm$ 10.8 7.27 $\pm$ 6.5	6,962	< 0.001* ²

*significant at $\alpha = 0.05$; ¹ Paired *t test* ; ² Independent *t test*

Based on table 4, the average pain score of the intervention group decreased with a mean difference between pre and post of 20.27 ± 3.61 , providing intervention with 3-sided splinting significantly reduced pain scores ($p < 0.001$ and t value 28.572). While in the control group the difference in pain score reduction was 7.19 ± 1.63 , with 2-sided splinting also significantly reduced pain scores ($p < 0.001$ and t value = 22.56). The average comfort of the intervention group had a difference in the

average increase of 24.5 ± 10.8 , with statistical results of providing 3-sided splinting interventions increasing comfort significantly ($p < 0.001$ and t score = -11.561). Meanwhile, in the control group, the difference in comfort improvement was 7.27 ± 6.5 , providing intervention with 3-sided splinting significantly increased comfort ($p < 0.001$ and t score = -5.663).

The influence of characteristics on pain and comfort

Table 5.

Effect of age and time from trauma to splinting on pain and comfort (n=52)

Effect of age and time from trauma to splinting on pain and comfort (n = 52)				
Variables				
Confounding	Dependent	Measurement	rs	P value
Age	Pain score	Pre-test	0.344	0.013*
		Post-test	0.373	0.007*
	Comfort	Pre-test	-0.348	0.012*
		Post-test	-0.324	0.019*
Time from trauma to splinting	Pain score	Pre-test	0.103	0.469
		Post-test	-0.010	0.944
	Comfort	Pre-test	-0.108	0.447
		Post-test	0.052	0.714

*significant on $\alpha = 0.05$ with Spearman test

In the pre-test measurement, age had a weak positive correlation with pain scores with a value of $r_s = 0.344$ and $p = 0.013$. In the post-test, the relationship remained significant with a value of $r_s = 0.373$ and $p = 0.007$. In the pre-test, the value of $r_s = -0.348$ with $p = 0.012$ was obtained, and in the post-test the value of $r_s = -0.324$ with $p = 0.019$. In the pre-test measurement, the relationship between trauma time to splinting and pain scores was with $p = 0.469$, while in the post-test with $p = 0.944$. The time from trauma to splinting did not have a significant relationship either in the pre-test ($r_s = 0.108$; $p = 0.447$) or post-test ($r_s = 0.052$; $p = 0.714$).

Results of the analysis of the influence of gender on pain and comfort

Table 4

Effect of gender on pain and comfort (n=52)

Variables		Measurement	n	Mean Rank		P value
Characteristics	Dependent			Male (n=31)	Female (n=21)	
Gender	Painful	Pre-test	52	26.5	26.5	0.993
		Post-test	52	26.9	25.9	0.830
	comfort	Pre-test	52	25.7	27.8	0.621
		Post-test	52	25.6	27.9	0.582

*significant at $\alpha 0.05$ with Mann Whitney Test

Based on table 6 Gender did not significantly influence pain reduction in pre-test ($p=0.993$) or post-test ($p=0.830$). Gender did not significantly influence comfort improvement in pre-test ($p=0.621$) or post-test ($p=0.582$). In other words, there was no significant difference between men and women in comfort.

Results of the analysis of the effect of analgesic use on pain and comfort

Table 7.

Effect of analgesic use on pain and comfort (n=52)

Variables		Measurement	n	Mean Rank		P value
Characteristics	Dependent			Yes (n=30)	No (n=22)	
Analgesic	Painful	Pre-test	52	27.1	25.8	0.760
		Post-test	52	26.5	26.5	0.993
	Comfort	Pre-test	52	27.1	25.7	0.753
		Post-test	52	26.4	26.7	0.934

*significant at $\alpha 0.05$ with Mann Whitney Test

Based on table 7, the use of analgesics did not significantly affect pain reduction in pre-test ($p=0.760$) or post-test ($p=0.993$) measurements and the use of analgesics did not significantly affect increased comfort in pre-test ($p=0.753$) or post-test ($p=0.934$) measurements.

Results of the analysis of the influence of fracture location on pain and comfort

Table 8.

Effect of fracture location on pain and comfort (n=52)

Variables		Measurement	n	Mean Rank		P value
Characteristics	Dependent			On (n=30)	Bottom (n=22)	
Fracture location	Painful	Pre-test	52	28.3	25.2	0.464
		Post-test	52	26.7	26.4	0.948
	comfort	Pre-test	52	25.0	27.6	0.541
		Post-test	52	28.5	25.0	0.415

*significant at α 0.05 with Mann Whitney Test

Based on table 8. Statistical analysis results showed that fracture location did not significantly affect pain reduction in pre-test ($p=0.464$) or post-test ($p=0.948$). Statistical analysis results showed that fracture location did not significantly affect comfort improvement in pre-test ($p=0.541$) or post-test ($p=0.415$).

Results of the analysis of the influence of fracture type on pain and comfort

Table 5

Effect of fracture type on pain and comfort (n=52)

Variables		Measurement	n	Mean Rank		Communicat ive (n=14)	P value
Characteristics	Dependent			Transversal (n=23)	Oblique (n=15)		
Fracture type	Painful	Pre-test	52	21.9	28.92	31.5	0.135
		Post-test	52	21.0	31.8	29.9	0.062
	Comfort	Pre-test	52	29.3	25.3	23.2	0.455
		Post-test	52	30.8	22.5	23.8	0.187

*significant at α 0.05 with Mann Whitney Test

Based on table 9 The statistical analysis results showed that fracture type did not significantly affect pain reduction in pre-test ($p=0.135$) or post-test ($p=0.062$). Fracture type did not significantly affect comfort improvement in pre-test ($p=0.455$) or post-test ($p=0.187$).

DISCUSSION

The effect of splinting on pain

The results of the study showed that the group that received 3-sided splinting experienced a greater reduction in pain score differences compared to the 2-sided splinting group. This condition can be explained because a 3-sided splint can provide better stabilization in the fracture area, thus minimizing the movement of bone fragments more effectively. When a fracture occurs, the displaced bone fragments will cause soft tissue damage, local bleeding, edema, and muscle spasms. Sensory nerves will receive nociceptive stimulation due to the release of inflammatory mediators such as prostaglandins, histamine, bradykinin, serotonin, and substance P. These stimuli are transmitted through the A-delta and C nerve fibers to the spinal cord and then forwarded to the cerebral cortex, resulting in the perception of pain (Schmidt *et al.* , 2021).

The results of this study align with research by Hassan *et al.* (2021), which found that the use of a 3-sided *splint* for lower extremity fractures resulted in more significant pain reduction than a 2-sided *splint* . The study explained that better stabilization can reduce the movement of bone fragments during patient transport and handling. Kim *et al.*'s (2022) study also reported that a more *rigid splinting technique* resulted in more effective pain control in orthopedic trauma patients compared to standard *splints* . This reduction in pain is related to reduced mechanical stimulation of

the injured tissue. In addition, research by Farsi *et al.* (2021) showed that early immobilization in patients with extremity fractures significantly reduced acute pain scores with a p value <0.001. The study confirmed that the quality of stabilization is an important factor in the success of non-pharmacological pain management.

According to the orthopedic trauma theory in *Rockwood and Green's Fractures in Adults*, optimal stabilization in the acute phase of a fracture plays a crucial role in reducing pain, preventing secondary soft tissue damage, and improving patient comfort before definitive (operative) therapy. The *Advanced Trauma Life Support* guidelines also recommend adequate immobilization as a key component of the initial management of musculoskeletal trauma to reduce pain and complications resulting from movement of bone fragments (*American College of Surgeons*, 2018).

The effect of splinting on comfort

More effectively limiting *multidirectional movement* (assuming a 33% pressure distribution on each side), while a 2-sided splint provides support on only two sides (assuming a 50%:50% pressure distribution). This greater stability helps reduce pain stimulation, muscle spasms, and tissue pressure, resulting in greater patient comfort after the procedure. In terms of tissue pressure, three-sided splinting tends to be more effective in reducing pressure on the soft tissues surrounding the fracture area. With two-sided splinting, micromobilization of bone fragments can still occur, potentially prolonging inflammation and edema. Conversely, three-sided splinting can more effectively reduce fragment movement, thereby minimizing tissue bleeding, edema, and tissue pressure.

Kolcaba divides comfort into three levels, namely *relief*, *ease* (calmness or psychological comfort), and *transcendence* (the ability to transcend the discomfort experienced). In orthopedic trauma patients, physical comfort is closely related to successful pain control and stabilization of the injured area. When pain is reduced and the extremity is more stable, patient comfort levels improve. This supports the theory that pain control and mechanical stabilization are key factors in improving the comfort of fracture patients. Research by Farsi *et al.* (2021) showed that *splinting* in patients with extremity fractures significantly improved patient comfort by reducing pain and increasing stability of the injured area. The study stated that patients who received more *rigid immobilization* reported a greater sense of comfort and safety during the acute phase of trauma.

Before splinting, unstable bone fragments can cause pain, edema, and pressure on blood vessels and nerves so that peripheral pulsation can decrease, movement becomes limited, and sensory disturbances such as numbness or tingling appear. After splinting, stabilization of bone fragments is expected to reduce movement, pain and swelling so that tissue perfusion is maintained and motor and sensory function can be maintained. However, splinting that is too tight actually risks reducing distal perfusion and causing neurovascular disorders (Althoff & Reeves, 2023). The greater increase in comfort in the 3-sided splint group is thought to be caused by more optimal immobilization capabilities compared to the 2-sided splint. This more optimal stability has the potential to reduce irritation of tissues, blood vessels, and nerves, thereby helping to maintain PMS status. Therefore, the advantages of 3-sided splinting are more often seen in increased limb stability and decreased pain than in acute PMS changes (Faraz *et al.*, 2022; Geu *et al.*, 2024).

Analysis of respondent characteristics regarding pain and comfort

While the time between trauma and splinting is important in trauma management, its impact on pain and comfort is not always immediately apparent if other factors predominate. Effective pain relief is determined more by the quality and stability of splinting than by the speed of application alone. A fast but less stable splint can still cause pain due to movement of bone fragments, while a slightly longer but stable splint can provide better results in terms of pain control and comfort (Kim *et al.*, 2022). In this study, the time between trauma and splinting was likely not too far apart among

respondents, thus not causing significant variation to significantly impact pain or comfort scores. These results align with research by Bendall *et al.* (2019) which stated that immobilization time does not always correlate directly with pain intensity in trauma patients, especially if the patient has received adequate analgesia and initial stabilization. Furthermore, research by Farsi *et al.* (2021) found that although *splinting* is effective in reducing pain, the relationship between procedure time and patient comfort levels is not always significant because comfort is influenced by multidimensional factors such as psychological and environmental factors. According to Katharine Kolcaba's theory, patient comfort is not only determined by physical interventions but also by emotional aspects, the environment, and the individual's perception of the pain experience.

The results of this study are in line with research by Kim *et al.* (2022) which stated that gender was not related to changes in pain after immobilization in orthopedic trauma patients. The study showed that the effectiveness of *splinting* is more influenced by the quality of stabilization than by patient demographic characteristics. Research by Farsi *et al.* (2021) also found that male and female patients experienced relatively similar pain reduction after *splinting* for extremity fractures. Furthermore, research by Fillingim *et al.* (2009) explained that although there are biological differences in pain perception between men and women in chronic conditions, in acute trauma these differences are often insignificant due to the dominance of nociceptive stimuli resulting from tissue injury. Research by Bendall *et al.* also reported that improving the comfort of trauma patients is more influenced by stabilization and pain control than gender.

Research shows that analgesic administration is not significant in reducing pain or increasing comfort. This is because the onset of ketorolac medication is 30-60 minutes and the duration of action is 4-6 hours, while analgesic administration and splinting are carried out in the first 30 minutes after the patient arrives at the ER. The relationship between analgesic use and pain can be influenced by several factors, such as: different types of analgesics, variations in dosage and time of administration, differences in individual pain thresholds, fracture severity, and the presence of almost the same splinting intervention (Bendall *et al.*, 2019). The comfort of fracture patients is not only influenced by pharmacological pain control but also by: limb stability, sense of security, body position, anxiety, and the patient's psychological condition (Katharine Kolcaba, 2003). It is possible that the effect of splinting as an immobilization measure is one of the factors that plays a role in reducing pain non-pharmacologically.

Patients with upper and lower extremity fractures exhibited relatively similar pain and comfort responses after splinting. Therefore, the anatomical location of the fracture was not a dominant factor influencing changes in pain and comfort in this study. Although lower extremity fractures are often considered biomechanically more severe due to greater weight bearing and muscle mass, pain perception remains strongly influenced by individual factors such as pain threshold, psychological state, anxiety, analgesic use, and the quality of splinting stabilization (Farsi *et al.*, 2019). In acute fractures, pain perception is not only determined by the fracture type but is also influenced by: muscle spasm, soft tissue damage, inflammatory response, neurovascular condition, psychological factors, analgesic use, and the quality of immobilization or splinting. This results in patients with different fracture types experiencing relatively similar levels of pain and comfort (American College of Surgeons, 2018). The results of this study align with research by Kim *et al.* (2022) which states that pain reduction in fracture patients is more influenced by the effectiveness of splinting and stabilization than the fracture type itself. Research by Farsi *et al.* (2021) also showed that after splinting, patients with various fracture types experienced relatively similar pain reduction because the primary mechanism of pain reduction comes from immobilization of bone fragments. Research by Beeres *et al.* (2021) explained that comminuted fractures have a higher degree of instability, and patient pain perception is not always more severe than simple fractures because pain is strongly influenced by individual factors and soft tissue inflammation.

CONCLUSION

The study showed that the majority of respondents were men (59.6 %) of productive adult age (>35 years), experienced fractures in the lower extremity area (57.7%) with a transverse fracture line type (44.3%), and received standard analgesic therapy ketorolac (57.7%). The results of the bivariate analysis proved that both two-sided and three-sided splinting techniques had a statistically significant effect in reducing acute pain intensity and increasing patient subjective comfort scores ($p < 0.001$). However, comparative analysis showed that three-sided splinting (intervention group) was significantly more effective than two-sided splinting technique (control group) with a p value < 0.001 . Based on these clinical findings, it is recommended that nursing service management integrate the three-sided splinting technique into the revised Standard Operating Procedure (SOP) for orthopedic immobilization and intensify the In-House Training (IHT) program for trauma management for all emergency nurses. For nursing educational institutions, the results of this study are recommended to strengthen evidence -based nursing practice materials in the emergency and critical care nursing curriculum.

REFERENCES

- Althoff, A. D., & Reeves, R. A. (2023). Splinting – Contraindications & Complications. StatPearls Publishing . <https://www.ncbi.nlm.nih.gov/books/NBK537295/>
- American College of Surgeons. Advanced Trauma Life Support (ATLS) Student Course Manual. 10th ed. Chicago: ACS; 2018.
- Amran, TG, Dewobroto, W., & Guntoro, AH (2020). Puzzle Splint Product Business Model Design Using Lean Startup Method. *Journal of Industrial Engineering* , 9 (3), 204–211. <https://doi.org/10.25105/jti.v9i3.6650>
- Andri, J., Febriawati, H., Padila, P., J, H., & Susmita, R. (2021). Pain in Post-op Lower Extremity Fracture Patients with Early Mobilization and Ambulation. *Journal of Telenursing (JOTING)*, 2(1), 61–70. <https://doi.org/10.31539/joting.v2i1.1129>
- Armita, S., Hidayat, R., Safruddin, S., & Hisyam, M. (2025). Effect of Appliance Slipping and Deep Breathing to Decreasing Pain Scale in Patients. *An Idea Nursing Journal*, 4(1), 22–30. <https://doi.org/10.53690/inj.v4i01.472>
- Auerbach, P. S., Cushing, T. A., & Harris, N. S. (2016). *Auerbach's Wilderness Medicine* (7th ed.). Elsevier. (Chapter: Extremity Trauma and splinting).
- Bayusentono, S., Farhadi, A., Suwondo, A., Adyaksa, G., Kusuma, B. W. A., Widodo, R. A., Susatyo, A. Y. R., Wardana, R. M. A. W., & Yudistira, E. (2021). *Casting, Traction, & splinting: Buku Ajar Ortopedi & Traumatologi*. Airlangga University Press.
- Bendall JC, Simpson PM, Middleton PM. Prehospital splinting and patient outcomes in extremity trauma. *Injury*. 2019;50(2):424–429.
- Beeres, F. J. P., van Veelen, N., Houwert, R. M., et al. (2021). Open plate fixation versus nailing for humeral shaft fractures: a meta-analysis and systematic review of randomised clinical trials and observational studies. *European Journal of Trauma and Emergency Surgery*.
- Black, JM, & Hawks, JH (2014). *Medical-Surgical Nursing: Clinical Management for Desired Outcomes* (8th Edition, Vol. 3). Elsevier .
- Brogiene, L., Urbonaite, A., Baksyte, G., & Macas, A. (2022). Procedure-Related Access Site Pain Multimodal Management Following Percutaneous Cardiac Intervention: A Randomized Control Trial. *Pain Research and Management* , 1–9. <https://doi.org/10.1155/2022/6102793>
- Brunner, LS, & Suddarth, DS (2018). *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* (14th ed .). Wolters Kluwer .
- Chen, L., & Liu, X. (2023). Validation of the Visual Analog Scale (VAS) for acute pain measurement in emergency settings. *International Journal of Nursing Studies*, 145. <https://doi.org/10.1016/j.ijnurstu.2023.104555>
- di Maio, G., Villano, I., Ilardi, C. R., Messina, A., Monda, V., Iodice, A. C., Porro, C., Panaro, M. A., Chieffi, S., Messina, G., Monda, M., & la Marra, M. (2023). Mechanisms of Transmission

- and Processing of Pain: A Narrative Review. *International Journal of Environmental Research and Public Health*, 20(4). <https://doi.org/10.3390/ijerph20043064>
- Faidah, N., & Alvita, GW (2022). The Effect of Splinting on Pain Levels in Fracture Patients in the Emergency Department of Dr. Loekmono Hadi Kudus Regional Hospital. *Journal of Nursing Profession*, 9(1), 1–9. <http://jurnal.akperkridahusada.ac.id>
- Faraz, A., Al-Ashqar, M., Khan, S., & et al. (2022). Documentation of neurovascular assessment in fractures. *Journal of PubMed /Cureus*, 14(7).
- Farsi D, Zare MA, Abbasi S, et al. Effect of splinting on pain reduction in extremity fracture patients. *Emergency Medicine International*. 2021 ;2021:1 –7.
- Ferdianto, IA, & Prastawa, H. (2023). Identification of Four-Wheeled Vehicle Component Damage Using the Failure Modes and Effects Analysis Method at PT. XYZ. *Industrial Engineering Online Journal*, 12(1).
- Fillingim RB, King CD, Ribeiro-Dasilva MC, et al. Sex, gender, and pain: A review of recent clinical and experimental findings. *Journal of Pain*. 2009 ;10 (5):447–485.
- Geu, Y., Mardiyono, Sudirman, & Walin. (2024). The Effectiveness of Three-Sided Splinting on the Degree of Pain in Patients with Closed Fractures of the Lower Extremities in the Emergency Room. *Indonesian Journal of Global Health Research*, 6(2), 615–622.
- Hamunen, K., Kontinen, V., Hakala, E., Talke, P., Paloheimo, M., & Kalso, E. (2012). Effect of pain on autonomic nervous system indices derived from photoplethysmography in healthy volunteers. *British Journal of Anaesthesia*, 108(5), 838–844. <https://doi.org/10.1093/bja/aes001>
- Harmon, E., Chong, L., & Marruso, M. (2024). Factors associated with pain intensity and analgesic use during inpatient rehabilitation for hip fracture. *Rehabilitation psychology*. <https://doi.org/10.1037/rep0000560>
- Hassan MK, Ahmed FI, Rahman MM. (2021). Comparison of two-sided and three-sided splints in lower extremity fractures. *International Journal of Orthopaedics Sciences*.7(3):112–118.
- Hoppenfeld, S., & Murthy, V. L. (2015). *Treatment and Rehabilitation of Fractures*. Lippincott Williams & Wilkins. <http://www.worldwidewounds.com/1998/june/Laplace/laplace.html>. <https://doi.org/10.1097/j.pain.0000000000001939>
- Hosseini, A. F., Mullins, A. S., C, B. W. G., & D, M. T. (2022). Acute pain management for older adults. *Geriatric Medicine*, 22(4), 302–306. <https://doi.org/10.7861/clinmed.22.4.ac-p>
- I, K. K. R. (2019). *Laporan Riset Kesehatan Dasar (Riskesdas) 2018*. Balitbangkes Kemkes RI.
- Indrawan, R. M., & Hikmawati, I. (2021). Assistancy in nursing care of medical surgical nursing for patients with musculoskeletal system disorders (Femur Fracture) in Anggrek Room, General Hospital of Banjar City. *Jurnal Kolaborasi*, 4(1).
- Kim JH, Lee YS, Park JH. Effectiveness of splint immobilization in extremity fracture management in emergency settings. *Journal of Orthopaedic Surgery and Research*. 2022;17(1):412.
- Kolcaba, K. (2003). *Comfort Theory and Practice: A Vision for Holistic Health Care and Research*. Springer Publishing Company.
- Krabbe, P. (2017). *The Measurement of Health and Health Status*. Elsevier. <https://doi.org/10.1016/C2013-0-19200-8>
- Lautenbacher, S., Peters, J., Heesen, M., Scheel, J., & Kunz, M. (2017). Age changes in pain perception: A systematic - review and meta - analysis of age effects on pain and tolerance thresholds. *Neuroscience and Biobehavioral Reviews*, 75, 104 – 113. <https://doi.org/10.1016/j.neubiorev.2017.01.039>
- LeMone, P., Burke, K., Bauldoff, G., Gubrud, P., Levett-Jones, T., Hales, M., Berry, K., Carville, K., Dwyer, T., Knox, M., Moxham, L., Raymond, S., & Reid-Searl, K. (2017). *Medical-Surgical Nursing: Critical Thinking for Person-Centred Care* (3rd ed.). Pearson Australia.
- March, A., & McCormack, D. (2009). Nursing theory-directed healthcare: Modifying Kolcaba's Comfort Theory as an institution-wide approach. *Holistic Nursing Practice*, 23(2), 75–80. <https://doi.org/10.1097/HNP.0b013e3181a1105b>

- Martin, V. T., Xu, S.-Y., & Yu, B. (2025). Rising burden of upper extremity fractures in China (1990–2021): A national study linking falls, aging, and divergent global trends. *Injury*, 56, 112783.
- Mullins, S., Hosseini, F., Gibson, W., & Thake, M. (2022). Physiological changes from ageing regarding pain perception and its impact on pain management for older adults. *Clinical Medicine*, 22(4), 307–310. <https://doi.org/10.7861/clinmed.22.4.phys>
- Nie, H., Graven - Nielsen, T., & Arendt - Nielsen, L. (2009). Spatial and temporal summation of pain evoked by mechanical pressure stimulation. *European Journal of Pain*, 13(6), 592 – 599. <https://doi.org/10.1016/j.ejpain.2008.07.013>
- Nielsen, C. S., Staud, R., & Price, D. D. (2009). Individual Differences in Pain Sensitivity: Measurement, Causation, and Consequences. *The Journal of Pain*, 10(3), 231–237. <https://doi.org/10.1016/J.JPAIN.2008.09.010>
- Prasetyani, D., Fatmawati, S., & Prasetyo, A. (2025). The Effect of Splinting on the Pain Scale and Pulse Rate of Closed Fracture Patients. *Tens: Trends in Nursing Science* , 3(2).
- Rafiqi, SI, Budi, AWS, & Romaningsih, YE (2025). The Effect of Splinting on Reducing Pain Levels in Fracture Patients: A Case Study. *Journal of Professional Nursing Research* , 7 (2), 929–934. <https://doi.org/10.37287/jppp.v7i2.6449>
- Risnah, R., HR, R., Azhar, MU, & Irwan, M. (2019). Non-Pharmacological Therapy in Handling Pain Diagnosis in Fractures: Systematic Review. *Journal of Islamic Nursing* , 4 (2), 77. <https://doi.org/10.24252/join.v4i2.10708>
- Salehi, N., Janjani, P., Tadbiri, H., Rozbahani, M., & Jalilian, M. (2021). Effect of cigarette smoking on coronary arteries and pattern and severity of coronary artery disease: a review. *The Journal of International Medical Research* , 49 (12). <https://doi.org/10.1177/03000605211059893>
- Sananta, P., Julana, R., & Sugiarto, M. A. (2022). Profiles of children with lower extremity fracture at Saiful Anwar Malang Regional General Hospital from January 2016 to August 2020. *Open Access Macedonian Journal of Medical Sciences*, 10(B), 255–259.
- Surucu, L., & Maslacki, A. (2020). Validity and Reliability in Quantitative Research. *Business & Management Studies: An International Journal*, 8(3), 2694–2726. <https://doi.org/10.15295/bmij.v8i3.1540>
- Schmidt AH, Finkemeier CG, Tornetta P. Treatment of fractures and neurovascular assessment. *Journal of Orthopaedic Trauma*. 2021;35(6):S1–S6.
- Sembiring, EN, & Rahmadhany, FM (2022). Analysis of the application of acute pain nursing care in femoral fracture patients. *Journal of Healthy Human Health Sciences* , 1(1).
- Shetty, A., & Patil, A. (2024). Neurovascular assessment in acute orthopedic trauma: A review of the 5P's and emerging concepts. *International Journal of Orthopedics and Rehabilitation* , 15(1), 45–52.
- Smeltzer, SC, & Bare, BG (2015). *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* (12th Edition, Vol. 3). EGC .
- Surgeons, A. C. of. (2025). *Advanced Trauma Life Support (ATLS) Course Manual 11th Edition*. American College of Surgeons.
- Todd KH, Funk KG, Funk JP, et al. Clinical significance of reported changes in pain severity. *Annals of Emergency Medicine*. 1996;27(4):485–489.
- Tosun, B., Aslan, O., & Tunay, S. (2018). Preoperative position splint versus skin traction in patients with hip fracture: An experimental study. *International Journal of Orthopaedic and Trauma Nursing*, 28, 8–15. <https://doi.org/10.1016/j.ijotn.2017.07.002>
- Tosun, B., Aslan, Ö., Tunay, S., Akyüz, A., Özkan, H., Bek, D., & Açiksöz, S. (2015). Turkish version of Kolcaba's Immobilization Comfort Questionnaire: A validity and reliability study. *Asian Nursing Research*, 9(4), 278–284. <https://www.google.com/search?q=https://doi.org/10.1016/j.anr.2015.07.003>
- Varkey, B. (2021). Principles of Clinical Ethics and Their Application to Practice. *Medical Principles and Practice*, 30(1), 17–28. <https://doi.org/10.1159/000509119>

- Wang, X., & Ji, X. (2020). Sample Size Estimation in Clinical Research. *Chest*, 158(1), S12–S20.
<https://doi.org/10.1016/j.chest.2020.03.010>
- Zealley, A. K., & Aitken, R. C. B. (1969). A Growing Edge of Measurement of Feelings [Abridged].
Proceedings of the Royal Society of Medicine, 62(10), 993–996.
<https://doi.org/10.1177/003591576906201006>