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A Study to Assess the effect of Cutaneous Stimulation on Arteriovenous Fistula (AVF) Puncture Pain among Patients undergoing Hemodialysis in a selected Hospital at Bangalore.

[1]Mr.Chethan. H.S., M.Sc. Nursing, Medical Surgical Nursing Department, Ramaiah Institute of Nursing Education and Research, Bangalore, Karnataka, India.

[2]Mr.Yogeendraprabhu, Associate professor, Medical Surgical Nursing Department, Ramaiah Institute of Nursing Education and Research, Bangalore, Karnataka, India.

Corresponding Author: Mr. Chethan. H.S., M.Sc. Nursing, Medical Surgical Nursing Department, Ramaiah Institute of Nursing Education and Research, Bangalore, Karnataka, India.

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Abstract

This study was conducted to assess the effect of cutaneous stimulation on arteriovenous fistula puncture pain among patients undergoing hemodialysis through arteriovenous fistula. The study used a quasi-experimental time series with withdrawn and re-instituted treatment design. Thirty chronic kidney disease patients undergoing hemodialysis through an arterio-venous fistula in the hemodialysis isolation unit were selected using a non-probability convenient sampling technique. A structured interview schedule was used to gather socio-demographic data. In each of the four observations, the pain of the arterio-venous fistula puncture was quantified using a numerical pain rating scale. The second and fourth observations both used cutaneous stimulation, which was applied by rubbing the web between the thumb and index finger. Using repeated measures of ANOVA and chi-square test, the gathered data was analyzed. The findings showed that cutaneous stimulation was beneficial in lowering the pain associated with arteriovenous fistula puncture (F= 110.5283, p 0.05). There was no significant association between arteriovenous fistula puncture pain with socio-demographic variables.

Keywords: Chronic kidney disease, Hemodialysis, Arterio-venous fistula, Numerical pain rating scale, Cutaneous stimulation

Introduction

Chronic kidney disease is a growing medical, social, and economic problem in India, affecting both patients and their families. It's a progressive, irreversible loss of renal function in which the body's ability to maintain metabolic, fluid, and electrolyte balance is compromised. The glomerular filtration rate is less than 15 ml/min/1.73m^2 in majority of people with chronic kidney disease.

The majority of chronic kidney disease patients who present to tertiary care centres in India are in the last stages of their disease, at which point renal replacement treatment is their only alternative. Renal replacement

therapies such as hemodialysis, peritoneal dialysis, hemofiltration, and renal transplantation are now available, thanks to technological advancements in renal failure care. Renal replacement therapy, such as hemodialysis, is the most common treatment for chronic kidney disease patients. It's a life-saving treatment in which blood is removed from the body, circulated through a purifying dialyzer, and then returned to the body.

The development and maintenance of adequate blood access is one of the most important part of hemodialysis; without it, hemodialysis cannot be performed. The arteriovenous fistula, arteriovenous graft, and venous catheter are the most common vascular access locations, while the arteriovenous fistula is one of the most prevalent method. Arterio-venous fistulas are still the gold standard for vascular access in hemodialysis patients, according to the National Kidney Foundation Dialysis Outcome Quality Initiative report. Once fully developed, it has a high long-term patency rate and is rarely infected.

Patients on maintenance hemodialysis have ten arterio-venous fistula punctures every month and about 300 per year, and they will keep getting them until they get a kidney transplant. Punctures of the arterio-venous fistula cause a lot of discomfort. In hemodialysis patients, pain is an unavoidable side effect of arteriovenous fistula puncture. Pain is the fifth vital sign, and it is derived from the Greek word poine, which meaning penalty or punishment. Pain is defined as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of tissue damage, or both” by The International Association for the Study of Pain (IASP) in 1986.

Ricci, Kyle, and Timby (2009) described pain management options that included both pharmaceutical and non-pharmacological approaches. Behavioral-cognitive strategies such as distraction, relaxation, biofeedback, thought stopping, positive self-talk, guided imagery, and biophysical interventions such as cutaneous stimulation, massage, pressure, Transcutaneous electrical nerve stimulation (TENS), and heat and cold application are examples of non-pharmacologic interventions.

Pain is consistently at the top of the list of nursing diagnoses. Nurses are frequently involved in pain management. During arteriovenous cannulation, nurses use a variety of measures to relieve pain in hemodialysis patients. Local anaesthetic is one of the pain-relieving methods available during arteriovenous fistula puncture, however it is rarely utilised due to concerns about vasoconstriction, burning sensations, scarring, and infection.

Many people have recognized and recommended cutaneous stimulation, which includes touch, as a non-pharmacological pain treatment. Touch is a nonverbal, physical communication method in which skin receptors are triggered and messages are sent to the brain. It is thought to be the most primitive and basic form of human communication. "It's a universal phenomena to rub a hurting spot."

Cutaneous stimulation is an independent nursing intervention that is recommended to reduce pain in patients, and a practising nurse is qualified to provide it correctly. It is defined as the stimulation of the skin and underlying tissues to reduce unpleasant signs and symptoms such as pain, muscular spasms, and inflammation. Cold application, pressure, and massage are just a few examples of cutaneous stimulation techniques. The gate control theory established by

Ronald Melzack and Patrick Wall in 1965 best explains the action of cold as cutaneous stimulation.

This cutaneous stimulation can be combined with acupressure to improve pain control effectiveness. It's a holistic method that dates back 5000 years. The Hegu point, also known as LI-IV, is an acupressure point on the dorsum of the hand, between the first and second metacarpal bones, that is important in the large intestine meridian. The large intestine energy meridian pathway is bilateral and starts at the base of the index finger of the nail on the skin's surface. It passes through the arm and hand before crossing the shoulder blade's external end. The meridian then leaves the skin to link with the lower section of the lung and the transverse colon. At a place under the chin, it returns to the skin's surface. This is commonly used to treat shoulder and arm pains, as well as stiffness in the neck, scapula, and eye problems. The most efficient cutaneous stimulation point is on the opposite side of the pain.

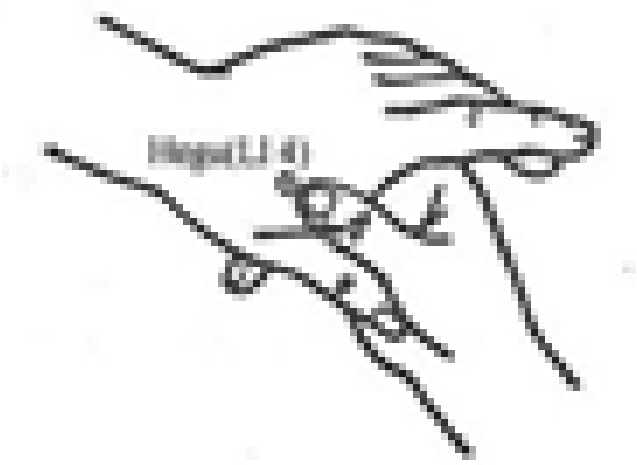


Figure 1

Hypotheses

H_1 –There is a significant difference in the arteriovenous fistula puncture pain scores for hemodialysis patients when they receive the cutaneous stimulation than when they do not receive it.

H_2 –There is a significant association between the level of arterio-venous fistula puncture pain with their selected socio-demographic variables.

Materials and methods

Design and setting: The effect of cutaneous stimulation on arteriovenous fistula puncture pain among hemodialysis patients was assessed using a quantitative approach in this study. The study's research design was a quasi-experimental time series with withdrawn and reinstituted treatment design.

Variables:

1. Independent variable: Cutaneous stimulation.
2. Dependant variable: Arteriovenous fistula puncture pain.
3. Socio-demographic variables: It includes age, gender, religion, education, occupation, annual family income, marital status, type of family and medical insurance, problems related to arteriovenous fistula, duration of hemodialysis, number of hemodialysis per week, an activity that worsens pain, fistula assessment, and any co-morbidities.

The setting of the study: The research was carried out in a selected hospital Bangalore among chronic kidney disease patients receiving hemodialysis through an arteriovenous fistula.

Sample size: Thirty individuals with chronic kidney disease who were on hemodialysis through an arteriovenous fistula.

Sampling technique: The sample was taken using a non-probability convenient sampling technique.

Inclusion and exclusion criteria

Inclusion criteria

1. Patients with chronic kidney disease who were on hemodialysis through an arterio-venous fistula in a selected hospital Bangalore.

2. Adult patients of both genders who were undergoing hemodialysis through an arteriovenous fistula and were able to respond appropriately to pain.

3. Patients who have been on hemodialysis for fewer than five years through an arteriovenous fistula.

4. Patients between the ages of 18 and 60 years old.

Exclusion criteria

1. Patients who were taking analgesics, have been diagnosed with peripheral vascular disease, or have diabetic neuropathy.

2. Patients who were unconscious or disoriented.

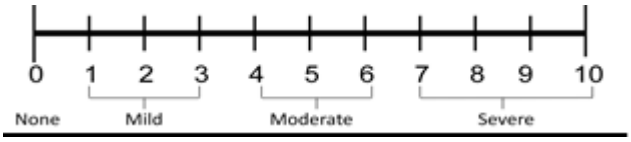
3. Patients those required more than one fistula puncture attempt.

4. Patients who refused to engage in the research.

Development of tool

Part I: Structured interview schedule, which includes socio-demographic variables such as age, gender, religion, education, occupation, annual family income, marital status, type of family and medical insurance, problems related to an arteriovenous fistula, duration of hemodialysis, number of hemodialysis per week, an activity that worsens pain, fistula assessment, and any co-morbidities.

Part II: Numerical pain rating scale



The arteriovenous fistula puncture pain was assessed using this scale. On a scale of 0 (no pain) to 10 (worst pain), patients judged the intensity of the best and worst levels of arteriovenous fistula puncture pain immediately after cannulation.

Scoring of the items

Part I: scoring was prepared by coding the socio-demographic variables.

Part II: scoring was done as, 0 – no pain, 1 – 3 mild pain, 4 – 6 moderate pain, 7 – 10 severe pain

Intervention: Cutaneous stimulation

The ice cube massage as cutaneous stimulation in between the index and thumb fingers of the contralateral hand of the arterio-venous fistula was the intervention. Determined the LI-4 meridian point before doing ice cube massage. To find this spot, asked the participant to hold his or her hand open and palm down. Researcher applied pressure by pushing his thumb against his own index finger in the centre of the fleshy web between the index and thumb finger on the contralateral hand of the participant's arterio-venous fistula. This made the muscle to protrude out and the highest point of the protrusion was the large intestine (LI) meridian IV. The researcher massaged the LI-IV meridian point with ice cubes wrapped in an unsterile glove ten minutes before inserting the arterio-venous fistula catheter needle and continued for two minutes throughout the procedure while the technician performed the arterio-venous fistula cannulation.

Data collection procedure

The hospital authority granted permission to perform the study. Each participant was introduced by the researcher, who explained the study's goal. A non-probability convenient sampling technique was used to pick 30 people who met the inclusion criteria for the study. After ensuring confidentiality, the participants gave their informed written consent. Part -I: Socio-demographic proforma was explained to each participant by the student researcher, who asked them to respond appropriately. Part II, the Numerical Pain Rating Scale, was explained to each participant, and they were asked to rate pain on a scale of 0-10 in each observation based on their perception of the arterio-venous fistula puncture pain.

The arteriovenous fistula puncture pain was assessed in each of the four observations, with cutaneous stimulation in the second and fourth observations prior to the arteriovenous fistula puncture pain evaluation. A numerical pain rating scale was used to quantify the level of arteriovenous fistula puncture pain on the first observation (O1). The level of arteriovenous fistula puncture pain was assessed using a numerical pain rating scale immediately after the arteriovenous fistula puncture on the second observation (X O2) after delivery of cutaneous stimulation. On the third observation (-X O3), the level of arteriovenous fistula puncture pain was assessed using a numerical pain rating scale without cutaneous stimulation during arteriovenous fistula puncture. On the fourth observation (X O4), the amount of arteriovenous fistula puncture pain was assessed using a numerical pain rating scale immediately following the arteriovenous fistula puncture after delivery of cutaneous stimulation. After four observations, thanked all the participants and ended the data gathering process.

Results

The data analysis was done by using descriptive and inferential statistics. SPSS (Version 20) was used to analyze the data. Descriptive statistics used in the study were frequencies, percentage, mean, and standard deviation. Repeated measures of ANOVA and Chi-square test were used for inferential statistics as deemed appropriate.

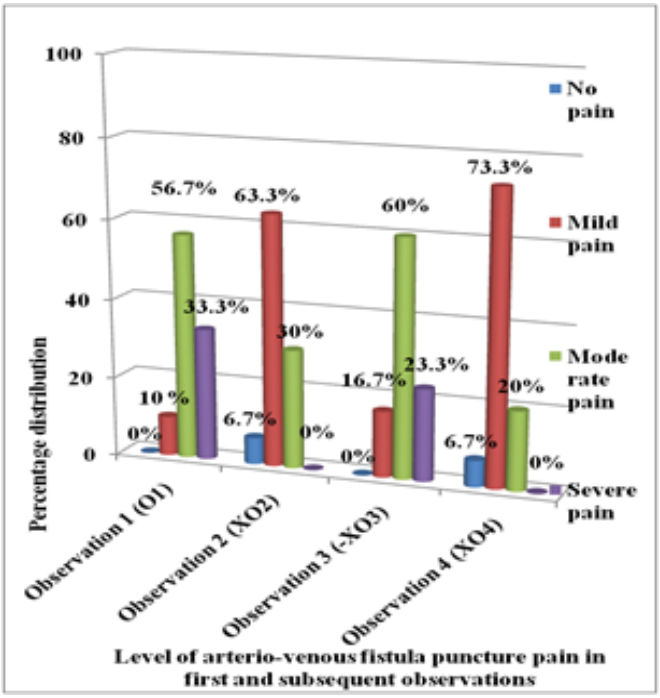
Table 1: Frequency and percentage distribution of socio-demographic variables of subjects n=30

Sn.	Socio-demographic variables	f	%
1.	**Age in years**		
	21-30	2	6.7
	31-40	3	10
	41-50	10	33.3
	51-60	15	50
2.	**Gender**		
	Male	24	80
	Female	6	20
3.	**Religion**		
	Hindu	24	80
	Muslim	4	13.3
	Christian	2	6.7
4.	**Educational status**		
	Profession	2	6.7
	Graduate	4	13.3
	Intermediate/ Diploma	5	16.7
	High school certificate	10	33.3
	Middle school certificate	2	6.7

	Primary School certificate	3	10
	Illiterate	4	13.3
5.	**Occupation**		
	Private sector	9	30
	Government service	7	23.3
	Self employed	4	13.3
	Unemployed	1	3.4
	Home maker	4	13.3
	Others	5	16.7
6.	**Annual family income**		
	10000-100000	3	10
	100001-500000	20	66.7
	500001-1000000	7	23.3
7.	**Marital status**		
	Married	27	90
	Single	2	6.7
	Widow	1	3.3
8.	**Type of family**		
	Nuclear	30	100
9.	**Medical insurance**		
	Yes	29	96.7
	No	1	3.3
10.	**Problems related to arteriovenous fistula**		
	No	21	70
	Yes	9	30
11.	**Duration of hemodialysis through arteriovenous fistula**		
	Less than 1 year	20	66.7
	1-2 Year	6	20
	2-3 Year	2	6.6
	3-4 Year	2	6.7
12.	**Number of hemodialysis per week**		
	2 times per week	4	13.3
	3 times per week	25	83.3
	4 time per week	1	3.4
13.	**Activity which makes pain worse**		

	Hand movement and improper position	2	6.7
	Nothing	28	93.3
14.	**Fistula assessment**		
	Normal	17	56.7
	Swelling	9	30
	Skin discoloration	2	6.7
	Swelling with skin discoloration	2	6.6
15.	**Comorbidity**		
	Hypertension	14	46.7
	Diabetes and Hypertension	7	23.3
	Diabetes, Hypertension and Coronary artery disease	5	16.7
	Hypertension and Coronary artery disease	4	13.3

The majority of the subjects (50%) were found to be between the ages of 51 and 60. Males made up the majority of the participants (80%). The majority of the subjects (80%) were Hindus, the majority of the subjects (33.3%) had a high school certificate, the majority of the subjects (30%) were working in the private sector, more than half of the subjects (66.7%) had annual family income of 10000 to 50,000 INR, more than half of the subjects (90%) were married, and all of the subjects were members of a nuclear family. The bulk of the participants (96.7%) had health insurance. More than half of the participants (70%) had no issues with an arteriovenous fistula. More than half of the individuals (66.7%) had used arteriovenous fistula for less than a year, 20% had used it for 1-2 years, 6.6% had used it for 2-3 years, and 6.7% had used it for 3-4 years. More than half of the participants (83.3%) had hemodialysis three times per week, 13.3% had it twice per week, and 3.4% had it four times per week. More than half of the participants (93.3%) stated that nothing will make the pain worse, while 6.7% stated that hand movement and improper position will worsen the pain. More than half of the participants (56.7%) had a normal arterio-venous fistula, 30% had a swollen fistula, 6.7% had skin discoloration, and 6.6% had a swollen fistula with skin discoloration. The majority of the participants (46.7%) had hypertension, 23.3% had diabetes and hypertension, 16.7% had diabetes, hypertension, and coronary artery disease, and 13.3% had hypertension and coronary artery disease.



Graph 1: Percentage distributions of the level of arterio-venous fistula puncture pain in first and subsequent observations

The above figure shows that more than half of the subjects had mild levels of arterio-venous fistula puncture pain after cutaneous stimulation.

Table 2: Comparison of arterio-venous fistula puncture pain before and after application of cutaneous stimulation n=30

Observation	O_1	X O_2	– X O_3	X O_4	F ratio value	p value
Mean	5.5	2.83	5.23	2.56	110.52 S*	0.00001
Std.Dev.	1.79	1.51	1.99	1.47		

S* = significant.

The above table shows that there is a significant difference in the level of arterio-venous fistula puncture pain before and after administration of cutaneous stimulation at $p < 0.05$.

Comparison of arterio-venous fistula puncture pain before and after application of cutaneous stimulation was calculated by repeated measures of ANOVA and calculated 'F ratio' value was 110.5283 at $P < 0.05$, hence, the research hypothesis (H_1) stated as "there is a significant difference in the arterio-venous fistula puncture pain scores for hemodialysis patients when they receive the cutaneous stimulation than when they do not receive it" was accepted and with regards to the association between level of arterio-venous fistula puncture pain with the selected socio-demographic variables, there was no significant association found, hence research hypothesis (H_2) stated as "there is a significant association between level of arterio-venous fistula puncture pain with the selected socio-demographic variables" was rejected.

Discussion

According to this time series with withdrawn and re-instituted treatment design, at the first observation, 10% had mild, 56.7% had moderate, 33.3% had severe arterio-venous fistula puncture pain, and none of them had no arteriovenous fistula puncture pain. 6.7% had no arteriovenous fistula puncture pain, 63.3% have mild, 33% have moderate arteriovenous fistula puncture pain, and none of them had severe arterio-venous fistula puncture pain during the second observation. During the third observation, 16.7% had mild arteriovenous fistula puncture pain, 60% had moderate, 23.3% had severe, and none of them had no arteriovenous fistula puncture pain. In the fourth observation, 6.7% reported no pain, 73.3% reported mild pain, and 20% reported moderate pain and none of them reported arterio-venous fistula puncture pain

The findings of the study is backed up by a cross-sectional study conducted at Santa Catarina State University in Chapeco, Brazil, on pain during arteriovenous fistula cannulation in chronic renal patients on hemodialysis. To assess pain severity during arteriovenous fistula cannulation, a total of 70 chronic renal failure patients undergoing hemodialysis were chosen. A visual analog scale was used to assess pain. The findings revealed that 58.5% of patients were in moderate pain, 30% were in severe pain, and 11.5% were in mild pain. The need for pre-cannulation analgesia to improve comfort during the procedure is highlighted in this study.

According to the findings of the current study, the mean pain score of individuals was 5.5 with a standard deviation of 1.7956 in the first observation, 2.8333 with a standard deviation of 1.5105 in the second observation, 5.2333 with a standard deviation of 1.9945 in the third observation, 2.5667 with a standard deviation of 1.4782 in the fourth observation. The F ratio was 110.5283, which is statistically significant (p 0.00001). The research hypothesis (H_1) "there is a

significant difference in the arterio-venous fistula puncture pain scores for hemodialysis patients when they receive the cutaneous stimulation than when they do not receive it" was accepted at $p < 0.05$, indicating that cutaneous stimulation is effective.

Randomized control research on the effect of cryotherapy on arterio-venous fistula puncture-related pain in hemodialysis patients backed up the findings. The research was carried out at AIIMS Delhi in India. Using an arterio-venous fistula, a convenience sampling technique was utilized to identify 60 patients undergoing hemodialysis, who were then randomly assigned to experimental and control groups using a randomization table. The subjective arterio-venous fistula puncture pain scores (1–2.5) on day 2 of hemodialysis were significantly lower ($P = 0.001$) than the values (2–7) on day 1 of hemodialysis. The agony of puncturing an arterio-venous fistula on days 1 and 2 of hemodialysis in the control group was found to be similar ($P = 0.23$) on two consecutive days. In terms of subjective arterio-venous fistula puncture pain, there was no significant difference ($P = 0.89$) in arteriovenous fistula puncture pain scores on the 2nd day of hemodialysis as compared to the scores on 1st day of hemodialysis. The objective and subjective pain were significantly ($P = 0.001$) reduced in the experimental group with the application of cryotherapy. This study highlights the need for adopting alternative therapies such as cryotherapy for effective pain management in hospital settings.

A similar Quasi-experimental study, Cutaneous stimulation its effect on pain-relieving among hemodialysis patients, was conducted at Menoufia University Egypt. A random sample of 52 hemodialysis patients who had arteriovenous fistula were taken as sample. Results revealed that less than half of the studied sample (46.2%) had severe arterio-venous fistula puncture pain and more than half of the studied sample (51.9%) had moderate pain before applying cutaneous stimulation. While after applying cutaneous stimulation less than half of the studied sample (46.2%) had mild pain during the second visit of the study and the third visit more than half of the studied sample (51.9%) had no arteriovenous fistula puncture pain at all. The study concluded that cutaneous stimulation is effective in reducing arterio-venous fistula puncture pain in hemodialysis patients, and recommended cutaneous stimulation to carry out routinely for managing arterio-venous fistula puncture-related pain among hemodialysis patients.

The association between the level of arterio-venous fistula puncture pain with the selected socio-demographic variables was calculated by using the chi-square test ($\chi 2$) and the value was less than the table value at $p < 0.05$ and hence research hypothesis (H_2) stated as "there is a significant association between level of arterio-venous fistula puncture pain with the selected socio-demographic variables" is rejected.

The findings of the study is supported by an experimental pre-test-post test study to assess the effectiveness of cold application on pre-procedure (AV fistula puncture) pain among hemodialysis patients in tertiary care hospital was conducted in Nellore, Andhra Pradesh, India. 60 patients undergoing hemodialysis via arterio-venous fistula patients were selected by simple random sampling technique through lottery method. The chi-square test results revealed that there was no statistically significant association between the post interventional pain score with the selected socio-demographic variables such as age, gender, education, occupation, the income of the family, period of AV fistula use, hemodialysis per week, sources of

psychological support and use of diversion therapy among the experimental group.

The findings of the study is challenged by a study conducted by Vipin Patidar in Gujarath, India, on the effectiveness of cryotherapy on pain during arteriovenous fistula puncture among hemodialysis patients. The duration of fistula use was linked to the severity of arterio-venous fistula puncture pain in this study.

A randomised control trial on the effect of cutaneous stimulation on arterio-venous fistula puncture-related pain in hemodialysis patients done at AIIMS Delhi, India, disputed the study findings as well. The duration of arteriovenous fistula use, the age of the subjects, and the gender of the subjects all had a significant relationship with arteriovenous fistula punctuation in this study and this may be due to cultural factors.

Limitation

1. Authenticity of the data is based on the responses of the samples
2. Limited sample size.

Conclusion

After receiving cutaneous stimulation, the majority of the studied subjects had mild arteriovenous fistula puncture pain. Thus, cutaneous stimulation is effective in reducing arteriovenous fistula puncture pain among patients receiving hemodialysis through an arteriovenous fistula, and there is no significant association between arteriovenous fistula puncture pain and selected socio-demographic variables.

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