

Effect of Cryotherapy on Pain Intensity at Puncture Sites of Arteriovenous Fistula for Children Undergoing Hemodialysis Therapy

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Abstract

Children undergoing hemodialysis are repeatedly exposed to pain from approximately 300 punctures per year to their AVF. Pain management are considered as the nursing priority and one of the important aspects of clinical nursing. Cryotherapy is one of the cutaneous stimulation methods. It has an important place among non-pharmaceutical treatments for pain control .Therefore, *this study aimed* to investigate effect of cryotherapy on pain intensity at puncture sites of arteriovenous fistula among children undergoing hemodialysis. *Study settings:* This study was conducted at pediatric hemodailysis unit affiliated to Pediatric Nephrology Department at Benha University Hospital . *The study sample:* Study subjects was consist of all available children undergoing hemodialysis therapy through their arteriovenous fistula over 6 months period in the previously mentioned setting. The children number were 40 children. *Tools of data collection:* Included a structured interviewing questionnaire , subjective pain rating scale, objective pain scale & numerical pain rating scale. *The results:* The present study revealed that, The mean of pain score during AVF puncture reduced in the studied children post cryotherapy than pre cryotheray. *The study concluded that:* cryotherapy was effective on diminishing pain intensity at puncture sites of arteriovenous fistula among children undergoing hemodialysis. *The study recommended that,* Hemodialysis units can apply cryotherapy technique to reduce AVF puncture pain among children underoing hemodialysis .

Key words: Hemodialysis, arteriovenous fistula , pain, cryotherapy.

Introduction

Chronic kidney disease (CKD) is a progressive, irreversible deterioration in renal function in which the body's ability to maintain metabolic, fluid and electrolyte balance fails. The incidence of CKD in the pediatric age group differs by region of the world. The prevalence of chronic Renal Failure (CRF) is high in the Arab world. The reported prevalence of CRF is 80 to 120 per million population (pmp) in Saudi Arabia and 225 pmp in Egypt. In Europe it is estimated to be 283 pmp, 957 in the United States and 1.149 pmp in Japan (*Ibrahim & Abd El-Gawad, 2017*).

Hemodialysis (HD) is extracorporeal removal of waste products such as creatinine and urea and free water from the blood when the kidneys are in a state of kidney failure. Hemodialysis is one of three renal replacement therapies (the other two being kidney transplant and peritoneal dialysis). Hemodialysis is a common method of renal replacement therapy for children with end-stage renal disease (ESRD). Over the last few decades, there have been advancements in dialysis equipment, medications, and treatment standards, leading to improved patient outcomes. (*Hothi et al., 2016*).

The presence of vascular access is vital for children with chronic kidney disease in hemodialysis, in order to establish a proper blood flux and guarantee the blood purification, ensuring the quality of dialysis. Arteriovenous fistulas (AVFs) are common form of chronic hemodialysis access. To carry out the hemodialysis treatment, AVF cannulation must be performed three to four times a week with thick needles. Despite this observation, AVF remains as the main choice of nephrologist teams, because it has minor risk of infection, assures proper functioning for a period of five years and requires lower demand for maintenance interventions (*Silva et al., 2016*).

Children undergoing hemodialysis are repeatedly exposed to stress and pain from approximately 300 punctures per year to their AVF. Considerable child discomfort and stress can be associated with the insertion of large-gauge needles into an AVF. Alleviation of this pain might improve their acceptance of the procedure and thus, their quality of life (*Celik et al., 2017*).

Relief of pain is a basic need and right of all children, effective pain management requires health professionals, including nurses, is willing to try a number of interventions to achieve optimal results. Basically, pain-reducing methods can be grouped into two categories, non pharmacologic and pharmacologic (*Alalo et al., 2016*). Pain assessment and management are considered as the nursing priority and one of the important aspects of clinical nursing. So, the need to find the new agents with maximum effect and minimal side effects which are accepted by all patients, is felt (*Davtalab et al., 2016*).

Cryotherapy is one of the cutaneous stimulation methods. It is a simple and cheap method that has an important place among non-pharmaceutical treatments for pain control. Cryotherapy, or the use of cooling, is a non-pharmacological pain relief technique that has been used for centuries. It lowers the temperature over the painful/inflamed area of the skin to reduce the velocity of nerve conduction in C- and A-delta fibers, thereby slowing the transmission of pain signals. It is simple, non-invasive, safe and an inexpensive nursing intervention that is advocated to minimize pain in patients (*Naji et al., 2016*).

Significance of the study

For a hemodialysis pediatric patient there is nothing more stressful than being exposed by big needles in the arteriovenous fistula site frequently. As sometimes

more than one try to place these needles correctly while accessing the suitable blood circulation is needed, doing hemodialysis three times a week makes the child expose to the skin bore and pain approximately 300 times per year. Therefore, decreasing part of these side-effects is so important to increase childs' coping with hemodialysis (*Madadi1 et al., 2017*). So it was important to nurses make study about various successful methods to control procedural pain such as cryotherapy as a non pharmacological pain management is expected to become integrated in the modern medical system as it is a complementary therapies.

Aim of the study

The aim of this study is to investigate the effect of cryotherapy on pain intensity at puncture sites of arteriovenous fistula for children undergoing hemodialysis therapy.

Research Hypothesis:

There will be a significant reduction in pain intensity after applying cryotherapy at puncture sites of arteriovenous fistula for children undergoing hemodialysis therapy.

Subjects and Methods

I-Technical design

Research Design:-

A quasi –experimental research design was utilized to conduct the study.

Settings:-

This study was conducted at pediatric hemodialysis unit affiliated to Pediatric Nephrology Department at Benha University Hospital .

Subjects:

Study subjects was consist of all available children undergoing hemodialysis therapy through their arteriovenous fistula (AVF) over 6 months period in the previously mentioned setting. The children number were 40 children. . In addition, the children were also included in the study from both sexes. All children were be selected according to the following criteria.

Inclusion criteria:-

Children aged 6-18 years, exposing to needle puncture without interventions done to decrease pain during puncture, healthy arteriovenous fistula skin (no signs of inflammation or infection).

Exclusion criteria:-

Children who positive to cold sensitivity test that was done by researcher or who have any contraindication for cold application e.g. vascular diseases. children on analgesic medications or having radiation injuries, peripheral vascular diseases, connective tissue disorders, diabetic neuropathy, alternated level of consciousness and suffering from pain of other origin than AVF was excluded from the study.

Tools of the study:

Data was collected through the following tools:-

Tool I:-A structured interviewing questionnaire: It was constructed by the researcher after reviewing the relevant literature. It was include the following items:

- A. Characteristics of the child such as:- age, gender, educational stage, age of the childetc.
- B. Past & present medical history of the child:- was checked from medical file of the child.
- C. Data related to arteriovenous fistula such as :- site of AVF, type of AVF ... etc.
- D. Data related to pain & needle puncture in AVF such as times of puncture in one session dialysis, child expression about pain...etc

Tool II: Subjective pain rating scale (Wong & Baker Faces Pain Rating Scale, 1988).

It was self report faces scale for acute pain. Six line drawn faces range from no hurt to hurts worst. It was adopted from **Wong and Baker(1988)**. Scoring system was used to divide pain into four levels as following: no pain(zero), mild pain (1-2), moderate pain(4-6) and severe pain(8-10).

Tool III :(A) Objective pain scale:-

This scale was adopted from **Norden et al(1991)**. This scale incorporates 4 pain behaviors (crying, movement, agitation and verbalization) and BP change. Each of these categories are scored from 0-2. Mean score for the different levels of pain was calculated as No pain (0), Mild pain (1-3), moderate pain (4-6), severe pain(7-10).

b- physiological measures of pain

This part consist of vital signs that was measured during puncture with and without cryotherapy.

Tool IV: Numerical pain rating scale (McCaffery & Beebe, 1993).

It is one of the standardized tools for quantifying pain intensity which consist of a scale with values ranging from 0-10 . Total pain tools score was 10. Mean score for the different levels of pain was calculated as follows:- no pain(zero), mild pain(1-3), moderate pain(4-6) and severe pain(8-10).

II-Administrative design:

Prior to data collection, a written permission to carry out the study was obtained from the director of each setting after submitting an official latter from the dean of the faculty of nursing at Benha University explaining the purpose of the study and methods of data collection .

III- Operational design:-

A-preparatory phase:

The researcher reviewed the local and international related literature covering various aspects of the study problem . using books, articles, international periodical and magazines. To prepare necessary tools for validity purposes.

Validity and reliability:

All tools were tested for content validity by 3 experts in Nursing fields. Then pain scales were tested for reliability by using Cronbach's Alpha reliability analysis.

Ethical considerations

All participants and their parents were informed about the aim of study, its benefits, and data collection tools in order to obtain their acceptance to participate. The researcher informed them that the participation in the study is voluntary; they have the right to withdraw from the study at any time, without giving any reason and that their responses would be held confidentially. An oral consent for acceptance for participation was obtained from children and their parents.

Pilot study

Pilot study was carried out on 4 children to check the clarity, applicability and feasibility of tools and make the necessary modification. No modifications were done to the tools. Therefore, the sample of the pilot study was included in the total study sample.

Field work

Data collection for this study was conducted for a period of 6 months starting from the first of April 2016 to the end of September 2016. The researcher visited the hemodialysis unit at Benha University Hospital two days weekly (Saturday & Thursday) from 7 A.M to 10 A.M to collect the data by using previous tools. The researcher interviewed child's parents individually and explained the nature and purpose of the study in order to be sure that every statement was understood and clear to every parent; each interview took from 15 to 30 minutes..

- The researchers initiated data collection by assessing socio demographic data, medical data and arteriovenous fistula site through interviewing each child and his/her parent individually using tool I. In addition, the researcher attended with children during carrying out AVF puncture to assess children response to pain.
- At first session only a usual needle punctures done for all children by nurse of the dialysis unit as hospital routine without any intervention and the researcher assess pain behavior during the AVF puncture to determine the objective pain scoring using tool II, tool III. Each child was asked after the AVF puncture to tick on the numeric pain rating scale to indicate how strong their pain during AVF puncture. Physiological measures of pain such as temperature ,heart rate, respiration and blood pressure were assessed for each child during AV fistula puncture.
- At the second session ice sensitivity test was done by the researcher to each child in the contralateral site to AVF to detect child sensitivity to ice. The used ice was 2-3cm ice of frozen distal water inside plastic bag.
- The researcher made ice massage (with ice of a frozen distal water inside plastic bag) by slow circular motion massage with interrupted periods to prevent skin injury. The procedure was started five minutes before venipuncture and continued throughout the puncturing procedure (approximately two minutes) or until skin numbness was felt (replacing the frozen ice bag occurred when necessary if ice melting start). Sterilization was done for puncture sites of the AV fistula as usual

protocol of sterilization in the unit. the researcher assess objective pain behavior during the AVF puncture to determine the objective pain scoring using tool II, tool III.

- Physiological measures of pain such as temperature ,heart rate, respiration and blood pressure were assessed for each child during AV fistula puncture with cryotherapy.
- After puncture with cryotherapy each child reviewed with the researcher how to tick on the numeric pain rating scale to indicate how strong their pain during AVF puncture using tool III.

IV-Statistical design:-

Data was coded and transformed into specially designed form to be suitable for computer entry process. Data was entered and analyzed by using SPSS (Statistical package for Social Science) version 20.

The collected data were organized, categorized, and analyzed, using frequencies, percentage, mean scores, standard deviation and chi-square test. Data were presented in form of tables and figures.

Result

Table(1):Distribution of studied children regarding personal characteristics(n=40).

Items	No	%
Age in years		
▪ 6- <9	4	10.0
▪ 9- <12	16	40.0
▪ 12- <15	6	15.0
▪ 15- ≤18	14	35.0
x-± SD 12.67±3.7		
Gender		
▪ Male	24	60.0
▪ Female	16	40.0
Education		
▪ Illiterate	15	37.5
▪ Primary	8	20.0
▪ Preparatory	8	20.0
▪ Secondary	8	20.0
▪ University	1	2.5
Child ranking		
▪ First	10	25.0
▪ Second	17	42.5
▪ Third	13	32.5
Residence		
▪ Rural	30	75.0
▪ Urban	10	25.0

Table(1):This table shows the characteristics of the studied children. The mean age of the children was 12.67 ± 3.7 , more than half of them (60.0%) were males, more than one third of them (37.5%) were illiterate , less than half of them (42.5%) were ranked as the second child in the family. Three quarters of them (75.0%) were living in rural residence.

Table(2): Frequency distribution of studied children regarding their medical history(n=40).

Items	No	%
Duration of hemodialysis (years)		
▪ < 1	2	5.0
▪ 1- < 3	19	47.5
▪ 3- < 6	13	32.5
▪ Others (≥ 10)	6	15.0
Chronic diseases associated with renal failure		
▪ No	24	60.0
▪ Hypertension	6	15.0
▪ Heart diseases	3	7.5
▪ Hepatic diseases	5	12.5
▪ Others (hypotension)	2	5.0
Numbers of hemodialysis sessions per week		
▪ Two sessions	0	0
▪ 3 sessions	37	92.5
▪ 4 sessions	3	7.5
Duration of hemodialysis session.		
▪ 2 hours	0	0
▪ 3 hours	24	60.0
▪ 4 hours	16	40.0

Table (2): This table reveals the medical history of the studied children. It reveals that in almost half of the children (47.5%) the hemodialysis duration were between 1- < 3 years, concerning diseases associated with renal failure less than one quarter of children (15.0%) had hypertension . Regarding number of dialysis session per week, most of children (92.5%) received 3 dialysis sessions per week, while the minority (7.5%) received 4 sessions per week and the duration of each dialysis session in hours the more than half of children (60.0%) were 3 hours, while more than one third of them (40%) were between 4 hours.

Table(3): Frequency distribution of pain level utilizing Wong-Baker faces pain rating scale in studied children during AV fistula puncture pre and post cryotherapy.

Pain level	Pre		Post		x ²	p-value
	No	%	No	%		
▪ No pain	0	0.0	13	32.5	66.25	0.000**
▪ Mild pain	0	0.0	22	55.0		
▪ Moderate pain	11	27.5	5	12.5		
▪ Sever pain	29	72.5	0	0.0		

highly statistically significant at p value <0.001

Table(3): illustrates that more than two thirds (72.5%) of children had severe pain during AVF puncture and almost third(27.5%) of them had moderate pain at pre cryotherapy. While post cryotherapy more than half of children(55%) had mild pain and almost third(32.5%) of them had no pain during AVF puncture. It also shows that there were highly statistical significant difference between level of pain pre and post intervention .

Table(4): Frequency distribution of pain level in the studied children regarding objective rating scale score during AVF puncture pre and post intervention.

Pain level	Pre		post		x ²	p-value
	No	%	No	%		
▪ No pain	0	0.0	13	32.5	65.88	0.000**
▪ Mild pain	0	0.0	22	55.0		
▪ Moderate pain	12	30.0	5	12.5		
▪ Sever pain	28	70.0	0	0.0		

Table(4): illustrates that more than two thirds (70%) of children had severe pain during AVF puncture and almost third(30%) of them had moderate pain at pre intervention. While post intervention more than half of children(55%) had mild pain and almost third(32.5%) of them had no pain during AVF puncture. It also showed that there were highly statistical significant difference between level of pain pre and post cryotherapy intervention.

Table (5) : Frequency distribution of pain level in the studied children regarding numerical rating scale score during AVF puncture pre and post intervention.

Score	Pre		Post		x ²	P value
	No	%	No	%		
▪ No pain	0	0.0	13	32.5	66.25	0.000**
▪ Mild pain	0	0.0	22	55.0		
▪ Moderate pain	11	27.5	5	12.5		
▪ Sever pain	29	72.5	0	0.0		

Table(5): showed that more than two thirds (72.5%) of children had severe pain during AVF puncture and almost third(27.5%) of them had moderate pain at pre intervention. While post intervention almost third(32.5%) of children had no pain ,more than half of them (55%) had mild pain and minority of them (12.5%) had moderate pain during AVF puncture. It also showed that there were highly statistical significant difference between level of pain pre and post intervention .

Table (6): Total mean score of pain regarding impact of cryotherapy on pain reduction between the studied children pre and post cryotherapy.

Pain assessment scales	Pre	Post	T	p-value
	$\bar{X} \pm SD$	$\bar{X} \pm SD$		
Wong-baker faces pain rating scale	8.30±1.80	1.80±1.74	26.4	0.000**
Objective rating scale	7.42±2.18	1.80±1.58	23.50	0.000**
Numerical rating scale	7.95±1.85	1.80±1.72	22.25	0.000**

Table (6): this table shows comparison mean score of pain during puncture pre and post cryotherapy . It was found that mean score of Wong-baker faces pain rating scale for studied children pre and post intervention was (8.30±1.80 , 1.80±1.74 respectively). . Also it was found that the mean score of objective rating scale pre and post intervention was (7.42±2.18 . 1.80±1.58 respectively). While the mean score of numerical rating scale pre and post intervention (0.72±0.45, 0.80±0.64 respectively). There were highly statistically significant differences between mean score of pain scale during AVF puncture pre and post cryotherapy .

Discussion

Regarding to the personal characteristics of the studied children, the results of the current study showed that, the mean age of the studied children was 12.67±3.7years. This result was similar to the result of a study by *Souza et al., (2011)* entitled (Hemodialysis vascular access in children and adolescents: a ten-year retrospective cohort study) who reported mean age of children was 12.5 years.

According to gender of the studied children, the results of the current study showed that, more than half of them (60.0%) were males. This result was similar to the result of study by *Abdel Salam et al.,(2014)* entitled (Assessment of depression and anxiety in children on regular hemodialysis) who found that half of children (50.0%) were males.

Regarding to the residence of the studied children, the findings of the current study showed that three quarters of them (75.0%) were living in rural residence. This

finding is supported with *Abou El Hana et al .,(2015)*, who found that the majority of studied children lived in rural areas(73.3%).

According to the medical history of the studied children, the current study found that, concerning diseases associated with dialysis, less than one fifth of children (15%) had hypertension, followed by children had hepatic disease and cardiac disease (12.5%,7.5 % respectively). This finding contrasted with *Hassan et al., (2012)*who found that more than one third of children (37.5%) had hepatitis, followed by more than one quarter of children had hypertension and cardiac disease(32.5%, 30% respectively).

As regard number of dialysis session per week,the current study found that most of children (92.5%) received 3 dialysis sessions per week, while the minority (7.5%) received 4 sessions per week, These findings is in an agreement with the study by *El- Karmalawy et al.,(2010)* entitled (knowledge, attitudes and practices of care givers of children with end stage renal disease on hemodialysis at Abu El Rish Pediatric University Hospital) who found that the most of studied children 98.1% had three times frequency/ week for hemodialysis. While only one child was attending four times weekly.

According to wong baker pain scores during AVF puncture pre and post cryotherapy , the current study found that more than two thirds (72.5%) of children had severe pain during AVF puncture and almost third(27.5%) of them had moderate pain at pre cryotherapy. While post cryotherapy more than half of children(55%) had mild pain and almost third(32.5%) of them had no pain during AVF puncture. This findings in the same lines with *Alalo et al .,(2016)* whom found that the mean self-report pain scores was lower among children in the study group than those in the control group as the following no pain 0% ,32% ,, mild pain 40%,36%, moderate pain 28% , 36%, severe pain 0% , 28% respectively.

The current study was found that mean score of Wong-baker faces pain rating scale for studied children pre and post intervention was (8.30 ± 1.80 , 1.80 ± 1.74 respectively). This finding agree with Egyptian study conducted by *Mansy et al., (2010)* to assessed the effectiveness of cryotherapy in relieving pain among children and reported significantly lower mean pain scores among children in the intervention group ($2.33 + 2.294$) than in the control group ($6.13 + 2.36$) .

The current study was found that the mean score of objective rating scale pre and post intervention was (7.42 ± 2.18 , 1.80 ± 1.58 respectively). Regarding to children's numerical rating scale score results revealed that an average score before cryotherapy was 0.72 ± 0.45 which decreased to 0.80 ± 0.64 after cryotherapy. In the same line, these findings were consistent with research conducted by *Patidar(2011)* who found an average objective assessment of pain before cryotherapy was 3.71 which decreased to 2.66 after cryotherapy. While average numerical rating scale score before cryotherapy was 4.01 which decreased to 2.98 after cryotherapy. This indicates that the cryotherapy is significantly effective in improving the level of pain among children undergoing hemodialysis with AV fistula.

The present study revealed that there was a highly statistical significant difference in relation to children's age and their level of pain pre and post intervention this finding supported with *Marie et al., (2013)* who reported that child age as influencing response to a medical procedure. Younger children display more behavioral distress and report more pain with medical procedures.

Regarding to the relationship between child gender and level of pain the current study found that there was no statistical significant difference between child

gender and level of pain pre and post intervention ($p > 0.05$). This finding was supported by *Celik et al (2011)* whom found that there was no significant relationship regarding pain & gender.

The findings of the study also illustrated that there was no statistical significant difference in relation to duration of hemodialysis and pain level in children pre and post intervention. This finding inconsistent with *Patidar (2015)* who found that duration of CKD and duration of AV fistula were found to have significant association with pain level during AV fistula puncture among hemodialysis patients.

Conclusion

Based on the current study findings, it was concluded that, cryotherapy was effective on diminishing pain intensity at puncture sites of arteriovenous fistula among children undergoing hemodialysis. In addition, there was a highly statistical significant difference in relation to children's age and their level of pain at puncture sites of arteriovenous fistula.

Recommendations

In the light of the study findings, the following recommendations are suggested:

- A similar study can be replicated in different setting to strengthen the findings.
- The same study could be replicated on a large sample size with newly cannulated pediatric patients.
- Further studies must be done in various other age groups of the pediatric population and on other painful procedures.
- Educational course about the application of an ice pack and its effect on minimizing the pain should be conducted for nursing staff.
- Inform and advise health care providers especially, pediatric nurses on the need to accept and assess a child's pain correctly, especially during painful procedures so nurses need to expand their knowledge and increase their responsibility.
- Haemodialysis units should involve cryotherapy for managing needle puncture pain in the routine care for children undergoing hemodialysis.

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