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Effect of Valsalva Maneuver Application versus Cryotherapy on Pain Intensity during Vascular Needle Insertion Among Children Undergoing Hemodialysis

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ABSTRACT

Background: Arteriovenous fistula puncture pain is a major stressful experience facing children undergoing hemodialysis. Complementary therapies such as cryotherapy and Valsalva maneuver are used to manage pain. **Aim:** Evaluate effect of Valsalva Maneuver application versus cryotherapy on pain intensity during vascular needle insertion among children undergoing hemodialysis. **Method:** A quasi-experimental design was utilized on a purposive sample of 80 school age children undergoing hemodialysis at Pediatric hemodialysis unit affiliated to Mansoura University Children's Hospital. **Tools:** three Tools were used to collect data: Tool I: Structured questionnaire sheet, Tool II: Wong–Baker faces pain rating scale&Tool III: Observational Scale for Behavioral Distress (OSBD). **Results:** revealed that the mean scores of Wong Baker faces pain and total behavioral distress scale was lower among children in Valsalva group than those in cryotherapy group. **Conclusion:** the study concluded that both Valsalva maneuver and cryotherapy had a positive effect on the reduction of arteriovenous fistula puncture pain for children undergoing hemodialysis but Valsalva maneuver was more effective in pain reduction than cryotherapy. **Recommendation:** the study recommended implementation of Valsalva maneuver should to be endorsed as a part of the routine care for hemodialysis children.

Keywords: Children, Cryotherapy, Hemodialysis, Pain, Vascular needle insertion, Valsalva maneuver

Introduction:

Chronic renal failure (CRF) is increasingly recognized as a global health concern and a major contributor to a poor prognosis. It is a severe illness that has been linked to a decline in patients' quality of life, a rise in medical expenses, and a significant financial burden on local communities. Chronic renal failure is "an irreversible loss of kidney function that can progress to end-stage renal disease (ESRD), it develops due to a multifactorial etiologies over a period of few years". The kidneys in this condition are unable to carry out metabolic processes and preserve fluid and electrolyte balance (Harada et al.,2022). Since CRF is asymptomatic in its early stages, the exact incidence in children is unknown. The incidence of CRF in children has steadily increased over the last 20 years, and the frequency of CRF in children is estimated to be between 18.5 and 100 per million worldwide. Compared to the overall population, children's mortality rates are between 30% and 150% higher (Al Shahawy et al., 2020).

The prevalence of chronic kidney disease (CKD) in children is unknown. Depending on whether the study's clinical definition of CKD was used, the prevalence of pediatric CKD in the European Union (EU) countries ranges from about 55–60 to 70–75 per million age-related populations in Spain and Italy (Masalskienė et al., 2021). The majority of poor countries do not have a patient register system. As a result, the exact number of CKD and ESRD patients remains uncertain. The burden of CKD was much higher than expected for the level of development in several regions, particularly Oceania, Sub-Saharan Africa, and Latin America, whereas the disease burden was lower than expected in western, eastern, and central Sub-Saharan Africa, east Asia, south Asia, central and eastern Europe, Australasia, and western Europe. 1.4 million (95% UI 1.2 to 1.6).

The prevalence of ESRD in Egypt has climbed to 483 patients per million, according to the 9th Annual Report of The Egyptian Renal Registry published by the Egyptian Society of Nephrology and Transplantation (ESNT) (El-Ballat et al., 2019). Whereas, other study in 2020 reported that the incidence of (ESRD) has increased by 30–40% in the last decade. These patients have a higher mortality rate of 3–8 times compared to the general population (Zahran et al., 2020).

Hemodialysis (HD) is the most common renal replacement therapy for end-stage renal disease (ESRD) and the preferred treatment option for enhancing kidney function. Even though it keeps kids alive, it interferes with his regular life.

The youngsters experience bodily issues during HD sessions, including headaches, muscle cramps, dizziness, exhaustion, nausea, vomiting, hypotension, and flushed faces. Additionally, they have psychological issues including stress, worry, and sadness that have a detrimental impact on their day-to-day lives (Bikbov et al., 2020).

Surgeon creates access to the bloodstream for hemodialysis, called vascular access which is frequently arteriovenous fistula. On average, children undergo hemodialysis three sessions weekly, each session lasting three to four hours. They experience the fistula puncture pain ten times per month at least, approximately 300 puncture per year and this pain is continuous during their life span or until a successful kidney transplant is performed (Vachharajani et al., 2021).

Pain inflicted by arteriovenous fistula puncture during hemodialysis is a significant cause of concern for children because of the diameter and length of needles. Pain assessment and management should be considered as a vital element of nursing care that nurses should perform alongside their roles for those delicate children. Consequently, nurses should be aware of the physical and mental consequences of this pain and apply effective strategies for its management (Alzaatreh, & Abdalrahim, 2020).

Management of pain includes pharmacological and non-pharmacological interventions. Non-pharmacological approaches include massage, active or passive distraction, imagery, explanation, therapeutic touch, heat or cold application and Valsalva maneuver. Complementary and alternative medicine therapy has the advantage of being easy to apply, cheap, non-invasive and causing no or the least side effects compared to pharmacological methods (Moisset et al., 2020).

In healthcare settings, the use of complementary and alternative medicines (CAM) has grown. New methods viewed the nurse as a healing force who plays a separate function in the treatment of patients. This method gave rise to the phrase holistic nursing. Nurses can improve complementary medicine by improving their professional practices. The phrase "complementary and alternative medicine" is most frequently used to refer to medical procedures and supplies that are mostly utilized outside of the official healthcare system (Khattab et al., 2018).

Valsalva maneuver is one of the non-pharmacological pain management, in which the child forcefully attempts expiration against a closed glottis. It mimics many normal and, in some cases, routine activities, such as straining during defecation, blowing up a balloon. Valsalva maneuver have no need to any equipment and it is easy to learn for children this maneuver causes distraction, it encourages a child to turn his or her attention to something aside from the agonizing experience. Furthermore, distraction methods are not only lessen pain and anxiety during painful and invasive interventions, but also reduce the number of trials needed to get the vascular access in a shorter period (Alan, & Khorshid, 2022).

Another non-pharmacological pain management is cryotherapy, that has been used for centuries as a topical pain reliever. It is easy to learn and inexpensive strategy that expands the pain threshold and decreases the inflammatory response and spasm. Ice massage produces cold stimulus as indicated by gate control theory as it inhibits the transmission of pain signals that hinder brain stimulation and perception of pain (Ebrahem et al., 2019).

Pediatric nurses play a vital role in managing the short-term and long-term issues of children with ESRD and their families by serving as caregivers and consultants during HD sessions. Nursing interventions aim to teach kids about non-pharmacological care in addition to preventing or treating HD consequences like weariness and cramping in the muscles (Mahmood, & Khudur, 2020).

Furthermore, non-pharmacological techniques work well to reduce pain during AVF needle insertion. However, since pharmaceutical therapies are expensive and may have side effects, pediatric nurses play a crucial role in helping kids with HD identify solutions that could alleviate or lessen these issues (Mahmood, & Khudur, 2020). This study will help nurses better care for children receiving hemodialysis by teaching them about Valsalva maneuver and the cryotherapy procedure, which reduces pain associated with arteriovenous fistula and improves the quality of life for the children.

Significance of the study

Every time an arteriovenous fistula is inserted, children receiving hemodialysis endure agony, which is thought to be one of the main reasons why they refuse treatment. Therefore, the primary focus of those pediatric patients' basic nursing care should be on managing discomfort

during fistula puncture (Beecham & Aeddula, 2021**).**

According to statistical records of Mansoura University Children's Hospital (MUCH), the number of children undergoing hemodialysis from 2020 to2021 was 4158 ,from 2021to 2022 was8549, from 2022to 2023 was8700 nearly ,about 250 case of school age children were undergoing hemodialysis in 2022 and 300 case of school age children were undergoing hemodialysis in 2023 (Unpublished Statistical Records from Mansoura University Children Hospital, 2020, 2021 ,2022 and 2023)

Children and their families may experience stress, avoid or limit the length of hemodialysis sessions, and experience a higher level of depression as a result of pain from fistula punctures(Al Shahawy et al., 2020). Few studies have been conducted in Egypt, namely at Mansoura University, to examine the impact of the Valsalva maneuver on pain during needle insertion. However, pain assessment and management using non-pharmacological modalities like cryotherapy and this move may be beneficial in treating this discomfort. This study will therefore be carried out in order to expand the body of knowledge and enhance nurses' methods for managing pain, which have an impact on children's lives.

Aim of the study

The aim of the study was to:

Evaluate effect of Valsalva maneuver application versus cryotherapy on pain intensity during vascular needle insertion among children undergoing hemodialysis

Subjects & method

I. Study Design

A quasi - experimental research design was used to accomplish this study.

II. Study Setting

This study was carried out at the pediatric hemodialysis unit connected to Mansoura University Children's Hospital (MUCH), in the Dakhlia governorate .

III. Study Subjects

A purposive sample of school age children undergoing hemodialysis (N = 80) attending the mentioned location and were chosen based on the following criteria

Inclusion criteria:

- Both sexes from6-12 years
- Conscious and their parents are agreeing to sharein the research.
- Children's arteriovenous fistulas are functional.

Exclusion criteria of children

- Using analgesic drugs during the past 3 hours
- Having vascular access other than fistula
- Requiring more than one attempt to puncture the fistula
- Cognitive disorders or presence of skin problems on the massage site.

Tool of data collection: Three tools were used to collect the necessary data:

Tool I: Structured questionnaire sheet: It developed by the researcher after reviewing related literature to collect child-related data from the parents and child (Al Salmi et al., 2021;Tatematsu et al., 2021; Tariq, Sulaiman,Farrukh, Goh, & Ming, 2022). It is consisted of four parts:

Part I: Demographic characteristics of the children under study encompassed their personal attributes, such as age, sex, educational attainment, and place of residence.

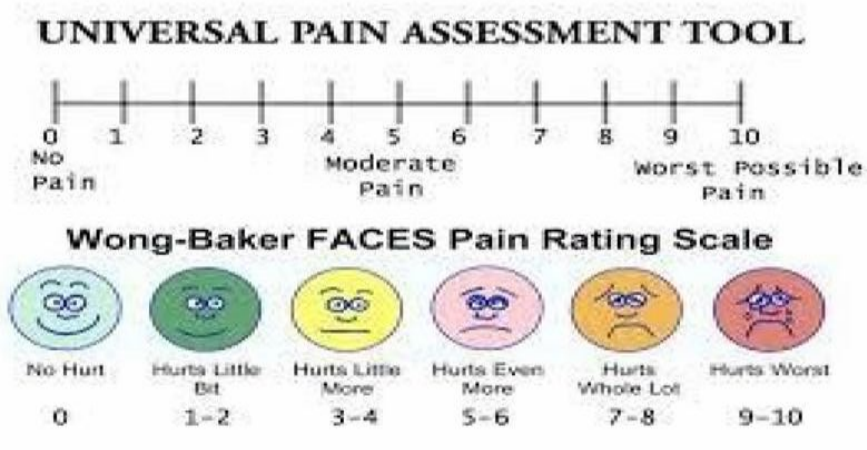
Part II: Children's medical history and clinical data, such as the length of their illness, co-morbidities (related conditions), the frequency and length of their hemodialysis, and the site, duration, and abnormalities of their arteriovenous fistula.

Part III: It covered physiological measures that the researcher measured before, during, and after needle insertion and that may be impacted by pain. Both study groups' blood pressure, oxygen saturation, pulse, and respiratory rate were measured.

Part IV: Assessment of needle insertion site In order to identify any local skin reactions from cryotherapy, such as redness, swelling, and pallor, was conducted before and after the needle puncture for the cryotherapy group exclusively.

Tool II: Pain assessment using Wong–Baker Faces Pain Rating Scale:

Wong–Baker faces pain rating scale was adopted from Wong & Baker, (1988). used to measure the subjective pain intensity of children during needle insertion. This tool translated from English to Arabic. Using back-translation method. The original form and the translations were contrasted. Five subject-matter experts made up the committee that reviewed and altered the final translations.



Scoring system of Wong–Baker faces pain rating Scale:

- No pain: (0) Mild pain: (1-3) Moderate pain: (4-6) Sever pain: (7-10)

Tool III: Observational Scale for Behavioral Distress (OSBD) Check list:

It was adopted from (Elliot, Jay &Woody, 1993). It used before, during and after the needle insertion to observe children's behavioral reactions which indicated discomfort (cry, scream, physical restraint, verbal resistance emotional support, information seeking, verbal pain and flail) at 15 second intervals throughout the procedure (fistula puncture), giving them score according to the severity of distress shown by the child. The scores summed for each 15 second interval within phases of the procedure and then will be divided by the number of intervals to obtain a mean score.

The scoring system of Observational Scale for Behavioral Distress (OSBD) Check list:

Each items is classified into (4) points according to the severity of distress where as:

-Sever distress (4) - Moderate distress (3)

-Mild distress (2) - No distress (1)

The total score of children behavioral distress includes the following:

- 70 % and more will be considered severe distress
- 60 %< 70% will be considered moderate distress
- 50% < 60% will be considered mild distress
- Less than 50% will be considered no distress

V. Data collection process:

The process of data collection was going through two phases:

Phase I: Preparatory phase:

This phase included a review of related literature and studies from the past and present, as well as the development of study instruments to become acquainted with the many components of the study research subjects using readily available books, periodicals, publications, and articles. The content validity of the study tools (tool I , II& III) was examined and revised by a panel of five experts in the field of pediateric nursing and according to their suggestions, the required modification was done. A statistician used Cronbach's alpha coefficient test in SPSS program, version 20 to examine the produced tools for dependability. It was tested on 8 children and the results were as the following: the Cronbach's alpha value of the Pain assessment using Wong–Baker faces pain rating scale is 0.896, and the Observational Scale for Behavioral Distress is 0.901

Pilot study

A pilot study was carried out on 10% of the total subjects (8 of children undergoing hemodialysis) randomly to show the tools' usefulness, feasibility, and clarity. Because no major changes were needed to the study, the pilot study participants were also included in the study's overall sample.

Fieldwork:

Data collection period

The information was gathered over the course of four months, starting fromDecember 1, 2023, to March 1, 2024. The researcher gave a brief introduction to the participants and explained the

nature and goal of the study. With the exception of Friday, the researcher visited the study setting every day from 8:30 am to 9:00 am and from 1:30 pm to 2:00 pm. All children who met the inclusion criteria underwent initial screening. Each child or caregiver gave their oral consent after being informed of the study's purpose.

The framework of the study was carried out in 4 phases as follow:

- Assessment phase.
- Planning phase.
- Implementation phase.
- Evaluation phase.

1-Assessment phase:

- During the initial interview, the researcher established a communication channel with caregivers and the participants by introducing herself. She explained the purpose and nature of the study before answering the questions to gain their cooperation to complete research instruments..
- Before implementing intervention , each child and his/her parent were interviewed individually to assess and collect baseline data using study tools (□, □ & □) pretest.
- Pre-test was accomplished in the duration of 1st week of December 2023.

2) Planning phase:

- Goals, priorities, and expected outcomes were developed based on the assessment phase's findings in order to address the knowledge and health-related practices that children and their caregivers require in order to insert needles into arteriovenous fistulas and manage their pain perception.
- The researcher planned for applying valsalva maneuver and cryotherapy on children over a period of 4 months.
- The researcher divided children into (2) groups each group containing 40 of them:
  - **Group I** (valsalva maneuver group)
  - **Group II** (cryotherapy group)
- The researcher planned for each child undergoing hemodialysis(3) sessions per week in both study group .
- Before implementing intervention , each child and his/her parent were interviewed individually to assess and collect baseline data using study tools (□, □ & □) .(first dialysis session) .

3) Implementation phase:

Group I (valsalva maneuver group):

- **In the second and third dialysis treatments that follow:** technique of valsalva maneuver taught to each child by researcher by asking the child to forcefully attempts expiration against a closed glottis as straining during defecation before, during and immediately after needle insertion.
- The researcher recorded the physiological measurements when children performing technique of valsalva maneuver before, during and after needle insertion (pulse, oxygen saturation, temperature, blood pressure, respiration rate).(this step took 2 minute)
- Then the child asked to complete Wong Baker scale before ,during and after needle insertion .Every child was asked to choose the face that best describes his/her feeling of pain. The number parallel to each face was recorded down by the researcher and she observed and recorded the behavior of children using tool III (this step took 2 -3minute)

Group II (cryotherapy group):

During the next two dialysis sessions (second and third session):

The researcher brought up an ice box to keep the ice in, sterile gloves for ice cubes, and smooth gauze for procedure.

- The ice pack was prepared by crushing small pieces of ice ,put in sterile gloves and wrapped up in smooth gauze to avoid skin tissue damage and prevent moistening the area of the puncture
- Each ice pack was labeled with child name to prevent cross infection.
- Ice sensitivity test was performed on the contra lateral site of AVF to determine presence of sensitivity.
- Prior to applying an ice pack, the researcher examined the arteriovenous fistula puncture site to look for any local skin reactions, such as redness, pallor, ecchymosis, and swelling. and documented using (tool 1, Part IIII).
- For five minutes, or until the child felt numb before the needle was inserted, the researcher used slow, circular, interrupted motions to massage ice over the AVF puncture site. This massage continued for two minutes during the puncturing operation and after the needle was inserted.

- The researcher inspected the arteriovenous fistula puncture site after application of ice pack to detect any local skin reaction from cryotherapy such as red ,pallor, ecchymosis and swelling. and recorded using(tool 1, Part IIII).
- The researcher documented the children's physiological parameters. using when was Appling ice pack before, during after needle insertion and (this step took two minutes)
- Then the child asked to complete Wong Baker scale (tool II)before ,during and after needle insertion and The researcher watched and documented the children's conduct this step took two minutes)
- The ice pack discarded it in plastic bag after finishing procedure.

4-Evaluation phase:

Tool II was used to assess the children in both groups' level of pain prior to, during, and following needle insertion and tool III before, during and after needle insertion in the three sessions to assess intensity of pain. A comparison between two groups was done to evaluate the effect of Valsalva maneuver versus cryotherapy on pain intensity among children undergoing hemodialysis.

Administrative design

- Two oral permissions to conduct the study were obtained from the head of the HD units in a previously mentioned setting after the purpose of the study was explained.
- The Dean of the Faculty of Nursing at Mansoura University sent an official letter to the relevant authorities in the chosen settings: (MUCH) to obtain permission for carrying out the study.

Ethical considerations

The study was conducted with ethical consent from Mansoura University's Faculty of Nursing's Research Ethics Committee. Each child's caregiver gave their oral consent after being informed of the study's purpose. Participants were aware of their freedom to leave the study at any moment. Data confidentiality and anonymity were guaranteed.

Results

Table 1 displayed the percentage distribution of the children under study according to their clinical data. it was observed that most of studied children (85% & 87.5%) receive hemodialysis treatment less than one year respectively in Valsalva and cryotherapy group. In addition to the majority of them (82.5% & 80.0%) were receiving three sessions weekly for 3 hours/session respectively in Valsalva and cryotherapy group and all of studied children (100.0% & 100.0%) respectively were connected to hemodialysis machine via AV fistula in both groups Valsalva and cryotherapy group.

Table (2) illustrated comparison of the Assessment of needle insertion site before and after cryotherapy implementation. It was found that there were statistically significant differences in the arteriovenous fistula assessment regarding the presence of pallor, ecchymosis, and swelling where (P=0.001, P=0.001, and P=0.001) respectively among children before and after cryotherapy implementation.

Table (3) showed Comparison between two groups according to Pain assessment using Wong–Baker faces pain before, during & after needle insertion. There were no statistically significant differences in both Valsalva and cryotherapy group among studied children regarding pain levels at first session before, during and after needle insertion (P=0.221, P=0.845, P= 0.761) respectively. While there were highly statistically significant differences in both Valsalva and cryotherapy group among studied children regarding to pain levels at 2nd and 3rd session before, during and after needle insertion (P= 0.024, 0.001, P= 0.001 & 0.004, P=0.001, P= 0.001) respectively

Figure (1). illustrated comparison of the observational scale score for behavioral distress at first session. Before needle insertion, it was found that, more than two thirds of studied children (70.0% & 65.0%) respectively in Valsalva and cryotherapy group have moderate distress. During needle insertion, it was found that 42.5% and half of them (50.0%) respectively have moderate distress in Valsalva and cryotherapy group. After needle insertion, it was found that more than one third of studied children (35.0%& 45.0%) respectively have moderate distress in Valsalva and cryotherapy group.

Figure 2. illustrated comparison of the observational scale score for behavioral distress at second session. Before needle insertion, it was found that, more half of studied children (57.5%) in Valsalva group have mild distress compared to 40.0% of them in cryotherapy group have mild distress. During needle insertion, it was found that more than two thirds (62.5%) of studied children in Valsalva group have mild distress and only 22.5% of them have moderate distress compared to 47.5% of them in cryotherapy group have mild distress and more than half of them (52.5%) have moderate

distress. After needle insertion, it was found that two thirds of studied children (60.0%) have mild distress in Valsalva group compared to half of them (50.0%) have mild distress in cryotherapy group.

Figure (3) illustrated comparison of the observational scale score for behavioral distress at third session. More than two thirds of studied children (67.5%) in Valsalva group have mild distress compared to 45.0% of them in cryotherapy group before needle insertion. Moreover, more than two thirds (70.0%) of studied children in Valsalva group have mild distress during needle insertion. After needle insertion, it was found that more than half of studied children (52.5%) have mild distress in Valsalva group and 47.5% of them have no distress compared to more than two thirds of them (65.0%) have mild distress in cryotherapy group and 12.5% of them have no distress

Table (1): Percentage Distribution of Studied Children According to Their Clinical Data.

	Group I (Valsalva maneuver group)		Group II (cryotherapy group)		Chi – Square / Fisher's exact test	
	N	%	N	%	X^2	P
Duration of hemodialysis treatment?						
< 1 year	34	85.0	35	87.5		
1 – 5 years	1	2.5	3	7.5		
More than 5 years	5	12.5	2	5	5.081	0.079
Session's hemodialysis / week						
2 times / week	0	0.0	0	0.0		
3 times / week	40	100.0	40	100.0	2.051	0.152
Duration of each session						
2 hours	0	0.0	3	7.5		
3 hours	33	82.5	32	80.0		
4 hours	7	17.5	5	12.5	4.129	0.127
Connection to the dialysis machine						
Through a normal blood vein (Fistula)	40	100.0	40	100.0		
Through artificial blood vein (GRAFT)	0	0.0	0	0.0	0.287	0.592

Table (2) Comparison of the Assessment of Needle Insertion Site before and After Cryotherapy in Percentage Distribution

	Pre		Post		Chi – Square	
	N	%	N	%	X^2	P
Redness						
Never	10	25.0	35	87.5		
Sometime	30	75.0	5	12.5	2.051	0.152
Pallor						
Never	29	72.5	34	85.0		
Sometime	11	27.5	6	15.0	26.869	<0.001**
Ecchymosis						
Never	10	25.0	34	85.0		
Sometime	30	75.0	6	15.0	29.090	<0.001**
Swelling						
Never	7	17.5	35	87.5		
Sometime	33	82.5	5	12.5	39.298	<0.001**

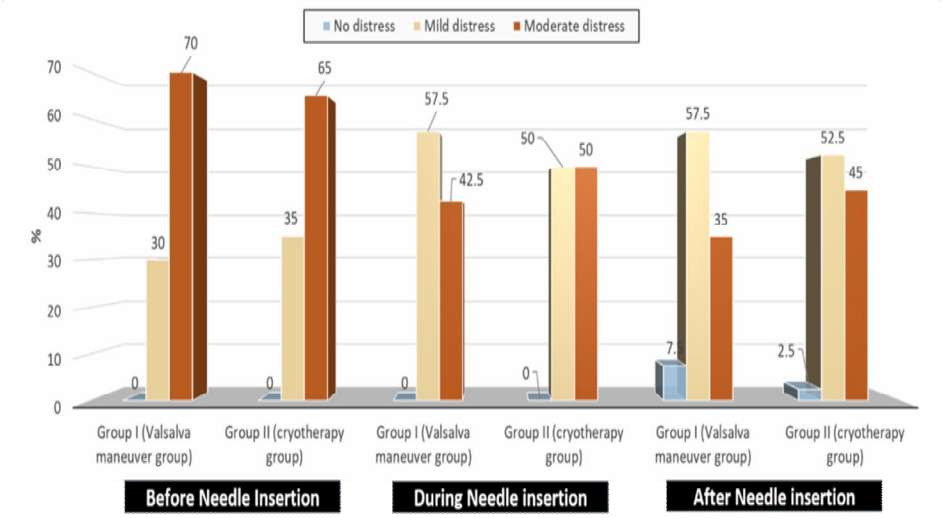


Figure (1). ***Comparison of the Observational Scale score for Behavioral Distress at First session***

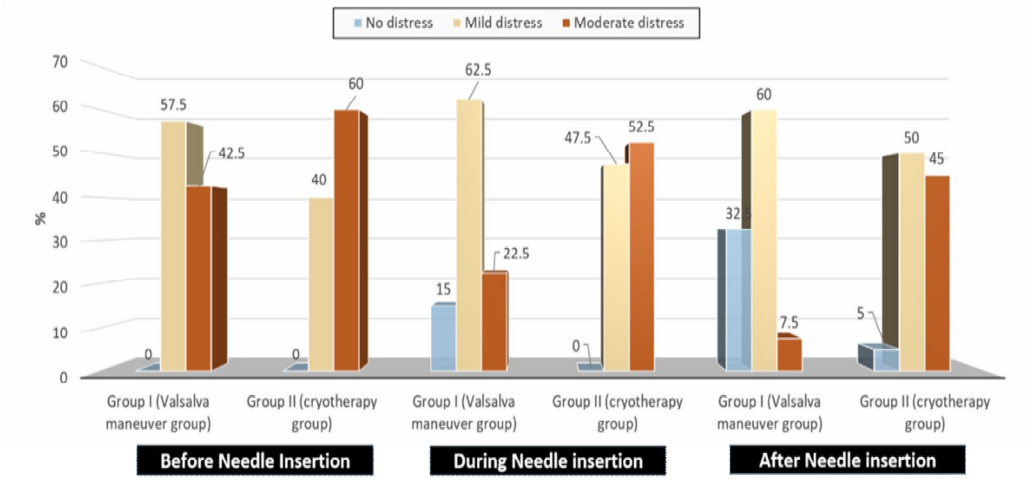


Figure (2) ***Comparison of the Observational Scale score for Behavioral Distress at second session***

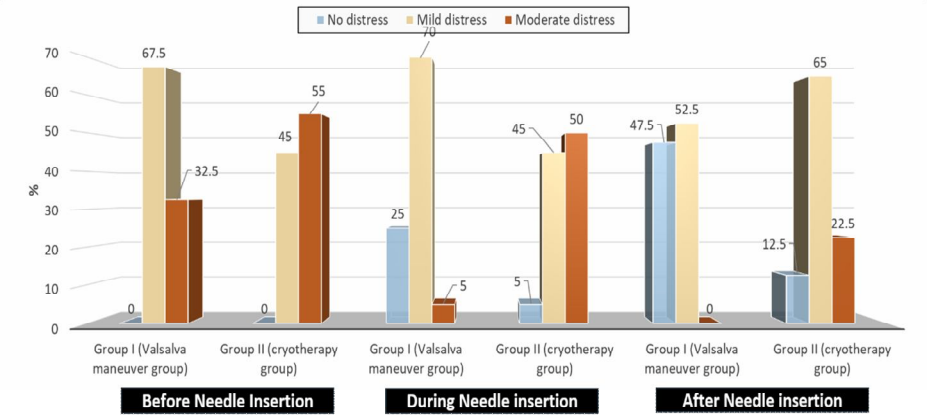


Figure (3) ***Comparison of the Observational Scale score for Behavioral Distress at third session***

Discussion

Arteriovenous fistula (AVF) cannulation pain may adversely impact the children's quality of life, and it is considered as the primary reason for the failure of them to tolerate dialysis via AVF (Kumar et al., 2021). Compared to medication, complementary therapies like cryotherapy and the Valsalva maneuver are safer and have fewer or no adverse effects. They are easy for kids to learn, don't require any additional equipment or setup, and not only reduce peripheral venous cannulation pain but also increase the chances of a successful venous cannulation insertion (Elhalafawy et al., 2020) Therefore, this study aimed to evaluate effect of valsalva maneuver application versus cryotherapy on pain intensity during vascular needle insertion among children undergoing hemodialysis

Regarding to clinical data of studied children, the results of current study revealed that most of studied children in both groups had undergoing HD treatment for less than one year. This finding was in the same line with finding of Hammam et al., (2024) who conducted a study entitled " Nurses' Performance Regarding Prevention of vascular Access Complications among Children Undergoing Hemodialysis " and reported that 80% of participants were undergoing HD for less than 1 year. However, all of study participants were undergoing HD treatment three times per week and more than two thirds of them had 3 hours for dialysis each session. These findings were in an agreement with Elhalafawy et al., (2020) who conducted a study entitled “Effect of cryotherapy versus aromatherapy on pain of arteriovenous fistula puncture for children undergoing hemodialysis” and reported that most of the children undergoing HD in her study received three dialysis sessions weekly, the duration of each dialysis session was three hours or more hours. From the researcher point of view, this may be due to the duration and number of HD session depended on child weight, laboratory investigations, and condition of kidney.

Regarding the cryotherapy group, the results of this study made it clear that children before and after cryotherapy application had statistically significant variations in the arteriovenous fistula assessment in terms of the existence of pallor, ecchymosis, and swelling (table 2). According to the study, this outcome can be linked to the way that ice massages diminish capillary permeability and the production of inflammatory mediators, which in turn lessen swelling and edema. This results was consistent with those of Attia & Hassan (2017) and Neamah & Ali (2023), who backed up the current finding and noted that cryotherapy was useful in lowering pain, swelling, edema, inflammation, and speeding up the healing process.

Regarding the severity of pain associated with AVF cannulation among the studied children, the current study revealed that the mean score of pain in Valsalva group reduced on the second and third sessions after application of study intervention than in the first session where studied children received routine care. This was in line with Sadek et al., (2024) who clarified that Valsalva group showed a statistically significant lowering in pain level compared to the control group. This may because Valsalva maneuver diverts the child's attention from the painful procedure and can result in pain reduction.

With respect to the cryotherapy group, this study demonstrated that there are significant variations in the overall mean pain intensity scores between HD children before intervention and cryotherapy prior to, during, and following needle insertion. These conclusions are corroborated by the findings of numerous studies on cryotherapy (Neamah & Ali, 2023 & Dehghan et al., 2023 & Ebrahem et al., 2019 & Patidar, 2019), which established and demonstrated that cryotherapy was a successful technique for lowering pain scores at AVF puncture sites in HD children. Furthermore, Fathalla and Bayoumi's (2018) study discovered that cryotherapy was a useful technique for lowering discomfort and anxiety during the collection of blood samples. Additionally, Susam et al. (2018) shown that cold had a pain-relieving impact during needle insertion.

According to the current study, most children's pain levels decreased from moderate to severe during the first session of ice massage to mild during the second and third sessions. According to the researcher, the present outcome can be explained by the fact that ice massage lowers skin temperature, which slows peripheral nerve fiber conduction velocity and reduces the release of inflammatory and nociceptive mediators, which causes skin anesthesia and a local anesthetic effect rather quickly. This result was consistent with a study by Elsayed et al. (2020) who found that children's mean pain scores during arteriovenous fistula punctures decreased after cryotherapy application compared to before.

Concerning of comparing the effectiveness of Valsalva maneuver versus cryotherapy effect on AVF cannulation pain, the present study showed that both of the techniques reduced pain during and after AVF cannulation. However, cryotherapy had lower effect on pain than Valsalva maneuver. This can be related to The cardiopulmonary baroreceptor reflex arc can be activated by Valsalva maneuver, which may lead to decreased pain in hemodialysis patients caused by AV fistula insertion. Baroreceptor activation can trigger the Vagus nerve to transmit signals to the nucleus of the solitarius tract which is the point where the afferent nerves of the Vagus nervous system intersect with the nociceptive pathways of the spinal lamina. So that, because the AV fistula insertion also runs via the solitary tract, the Vagus nerve's impulses can block the nociceptive nerve's pain stimulation (Silva et al., 2016).

This results supported by Meenu and Balakrishnan's (2023) who conducted a study which entitled "Analogy and Collation of Valsalva Maneuver and Ball Compression on Pain during AVF Cannulation in pediatric Patients with Chronic Renal Failure on Hemodialysis" who found a statistical significant difference in the level of pain during AVF cannulation due to the positive effects of the Valsalva maneuver. Additionally, Alan and Khorshid (2022) who conducted a study which entitled “Evaluation of efficacy of Valsalva maneuver during peripheral intravenous cannulation on pain” and found that patients in the Valsalva group experienced statistically significant less pain intensity during peripheral intravenous catheter (PIVC) insertion than those in the control group.

In terms of behavioral distress, the present study found that there were statistically significant differences between pre and post-intervention, and that the mean behavioral distress scores during and after needle insertion in the Valsalva group decreased more on the third session than on the second. These findings were consistent with those of Sadek et al. (2024), who found that there were statistically significant differences between the pre and post-intervention among the children in the Valsalva group. This could be because the child got more comfortable, at ease, and interested in the approach during the third session, which results in a greater analgesic effect during the intervention.

With regard to the cryotherapy group, the current study found that there were statistically significant variations between pre and post-intervention in the mean behavioral distress scores during and after needle insertion on the second and third sessions of implementing the intervention. A study by Elhalafawy et al. (2020) titled "Effect of cryotherapy versus aromatherapy on pain of arteriovenous fistula puncture for children undergoing hemodialysis" came to the same conclusion. and discovered statistically significant difference between the pre and post intervention periods, as well as a decrease in the cryotherapy group's mean values of behavioral discomfort after fistula puncture in the third session.

Conclusion

According to the current study's findings, children undergoing HD experienced less pain and behavioral distress symptoms following AVF puncture while using both Valsalva maneuver and cryotherapy; nevertheless, Valsalva method proved to be more successful than cryotherapy.

Recommendations

1. Using Valsalva maneuver and cryotherapy in order to alleviate pain in children Prior to AVF cannulation.
2. A training program for pediatric nurses working in dialysis units about various non-pharmacological pain management techniques, including the Valsalva maneuver and cryotherapy should be conducted.
3. Future studies on the Valsalva maneuver is strongly recommended. These studies should include a larger sample size from diverse geographic locations, various ages, and other painful invasive procedures to achieve more generalized results.

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