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Effect of cryotherapy on pain management at the puncture site of arteriovenous fistula among children undergoing hemodialysis

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ABSTRACT

Objective: To evaluate the effectiveness of cryotherapy in managing the pain at the puncture site of Arterio-Venous Fistula (AVF) among children undergoing maintenance hemodialysis (HD).
Methods: A one-group pre-post quasi-experiment was performed in two HD centers affiliated with Cairo University. The experiment involved 40 children with AVF undergoing HD. Before puncturing, cryotherapy was applied using 2 cm–3 cm pieces of frozen distilled water in a plastic bag. Pain was assessed subjectively and objectively in two dialysis sessions before and after cryotherapy. A part from a physiological assessment of vital signs, pain was assessed using the Wong–Baker Faces Pain and the Observed Pain Behavior rating scales. All research ethics were applied.
Results: HD had a median duration of four years, while cryotherapy had a median application time of 8.8 min. The Wong–Baker Faces Pain score and almost all observed pain behaviors significantly decreased after cryotherapy. Significant improvements were observed in respiratory rate before and after needle puncture and in oxygen saturation after needle puncture. A lower skin dryness was observed after cryotherapy (12.5%) than before cryotherapy (52.5%; $p < 0.001$).
Conclusions: Cryotherapy can effectively reduce the venipuncture pain among children with AVF undergoing maintenance HD. However, the confounding effects of distraction and the non-randomized design used must be both considered when interpreting the findings. This study recommends the use of cryotherapy in managing needle puncture pain. Further research must adopt a randomized trial design with a placebo to support further the benefits of this procedure.

1. Introduction

Children with arteriovenous fistula (AVF) and undergoing maintenance hemodialysis (HD) are exposed to an average of 10 AV fistula punctures a month, which is expected to continue for the rest of their lives [1]. These punctures are associated with pain and stress among children and their families [2], and are characterized by the use of large gauge needles [3]. Unrelieved continuing pain may have untoward effects on the health, functional abilities, and quality of life of children [4]. Properly managing the pain from these punctures is associated with shorter hospital stays and lower hospital costs [5]. Freedom from pain is a right of children and must be considered in nursing practice [6].

Understanding the physiology of pain, its influencing factors, and effective management can help nurses individualize their care plans for these children [7]. The lack of pain knowledge presents an important barrier to proper pain management [8]. Given that the perceptions of children toward pain are greatly influenced by environmental and psychological factors, the adoption of psychosocial strategies, education, parental support, and cognitive–behavioral nursing interventions may effectively reduce their anxiety and distress [9]. Therefore, as advocates for children, nurses are compelled to minimize the emotional and physical effects of painful procedures. They must also become aware of the different approaches to procedural pharmacological or non-pharmacological pain management [10]. Moreover, pain management becomes highly effective when the presence of pain is anticipated and when the right of children to pain control is acknowledged [5].

Cryotherapy, or the use of cooling, is a non-pharmacological pain relief technique that has been used for centuries [11]. Cryotherapy lowers the temperature over the painful/inflamed area of

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the skin [12] to reduce the velocity of nerve conduction in C- and A-delta fibers, thereby slowing the transmission of pain signals [13]. Despite being simple, non-invasive, and safe, the effectiveness of this technique, especially as an independent nursing function, lacks strong evidence. Therefore, the effectiveness of cryotherapy in relieving pain from AVF puncture was demonstrated during HD [1]. Conversely, a systematic review concluded that cryotherapy could effectively reduce pain among adults, but its effectiveness among children remains unknown [14]. Therefore, future studies must examine the effectiveness of cryotherapy in reducing pain among the pediatric population.

1.1. Aim of the study

This study aimed to evaluate the effectiveness of cryotherapy in managing pain at the puncture site of AVF among children undergoing maintenance HD.

1.2. Research hypotheses

The application of cryotherapy before AVF puncture among children undergoing maintenance HD can lead to the following:

1. lower Wong–Baker Faces Pain Rating Scale scores compared with pre-application scores;
2. lower Observed Behavior Pain Rating Scale scores compared with pre-application scores; and
3. better physiologic measures of stability compared with pre-application scores.

1.3. Operational definitions

Cryotherapy: Ice massage by applying 2 cm–3 cm of frozen distilled water inside a plastic bag over two AVF puncture sites until numbness is felt before needle puncture.

Physiologic measures: Respiration, pulse, blood pressure, and oxygen saturation.

2. Methods

2.1. Research design and setting

A quasi-experimental one-group design with pre-post assessment was applied. This study was performed in two centers, namely, the Center of Pediatric Nephrology and Transplantation in Elmonira Children's Hospital and the Center of Pediatric Dialysis in the Specialized Pediatric Hospital. Both centers and hospitals are affiliated with Cairo University.

2.2. Subjects

Forty children with AVF and undergoing maintenance HD were recruited from the two settings via convenience sampling from May 2011 to October 2011. Using the Epi-Info software, the sample size demonstrated a pre-post difference of 0.1 point or higher in the two pain scales with 0.1 point standard deviation at the 95% confidence level, 80% power, and expected 20% dropout. These children were considered their own controls in days 1 and 2 (before cryotherapy) for comparison with post-cryotherapy in days 3 and 4.

2.3. Data collection tools

The data collection tools included the following.

2.3.1. Structured interviews

A structured interview form was constructed to collect child-related data from the parents. The form covered the personal characteristics of the recruited children, including their age, gender, educational level, and residence. The medical history of children was also recorded, including the duration of their disease and co-morbidities, the duration and frequency of their HD, and the condition of their AVF.

2.3.2. Wong–Baker faces pain rating scale

The Wong–Baker Faces Pain Rating Scale was developed as a self-report scale for subjective pain assessment. The scale includes six drawn faces expressing various degrees of pain severity ranging from “does not hurt” to “hurts very much” [15]. These faces are assigned scores from 0 to 10, with a higher score indicating a higher severity of pain [16]. Apart from being simple and acceptable, this scale has high test–retest reliability and convergent validity [17]. The scale has a high reliability with a Cronbach's alpha coefficient of 0.70.

2.3.3. Observed pain behavior rating scale

Based on the Procedure Behavior Checklist Scale [18], the Observed Pain Behavior Rating Scale offers an objective assessment of pain. The scale includes eight observable behaviors (screaming, crying, verbalized pain, verbalized anxiety, verbal stalling, muscle tension, physical resistance, and use of restraint). The intensity of these behaviors is rated on a five-point Likert scale ranging from 1 (“very mild”) to 5 (“extremely intense”). The scale has favorable psychometric properties [19]. The researchers modified the scale to suit the cognitive ability of children; in this case, the behaviors observed to have “occurred” were scored 1, while those that “did not occur” were scored 0. The scores of the eight behaviors were summed to obtain the total score, and a higher total score indicates a higher pain severity. The modified scale has a Cronbach's alpha coefficient of 0.74.

2.3.4. Physiological assessment

The physiological measurements that could be influenced by pain were assessed. These measurements included respiratory rate, pulse, systolic and diastolic blood pressures, and oxygen saturation. Standardized assessment methods were employed.

2.4. Pilot study

A pilot study was performed on 10% of the total sample (four children) to pre-test the data collection tools in terms of their clarity, applicability, and time to completion. Minor modifications were applied before finalizing the tools. The children who participated in the pilot study were excluded from the sample.

2.5. Procedures

The participants were recruited upon receiving their permission. The researchers met the children who satisfied the inclusion criteria as well as their parents in the study settings, gave them a clear and simple explanation of the aim and procedures of the study, and invited them to participate. Those children and parents who agreed to participate signed an informed consent form. The researchers then interviewed the children and their parents individually in the waiting room using the interview form before the dialysis session. Afterward, the researchers explained to the subjects the subjective pain assessment tool, the Wong–Baker Faces Pain Rating Scale, and then trained the children on how to use this scale. The cryotherapy procedure was then explained and

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