Vapocoolant Spray Effectiveness on Arterial Puncture Pain: A Randomized Controlled Clinical Trial

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Abstract- Arterial blood gas (ABG) sampling is a painful procedure with no perfect technique for quelling the discomfort. An ideal local anesthesia should be rapid, easy to learn, inexpensive, and noninvasive. This study was aimed to compare pain levels from ABG sampling performed with vapocoolant spray in comparison to placebo. We hypothesized that pretreatment with the vapocoolant would reduce the pain of arterial puncture by at least 1 point on a 10 point verbal numeric scale. We have evaluated the effectiveness of a vapocoolant spray in achieving satisfactory pain control in patients undergoing ABG sampling in this randomized placebo controlled trial. Eighty patients were randomized to 2 groups: group A, who received vapocoolant spray, and group B, who received water spray as placebo (Control group). Puncture and spray application pain was assessed with numerical rating scale (0, the absence of pain; 10, greatest imaginable pain) and number of attempts was recorded. The pain score during ABG sampling was not lower in group A compared with group B significantly (4.78±1.761 vs. 4.90±1.837; *P*:0.945). This study showed that while the spray exerts more application pain, the number of attempts required for ABG sampling was not significantly lower in group A compared with group B (1.38±0.54 vs. 1.53±0.68; *P*=0.372). Vapocoolant spray was not effective in ABG pain reduction, had milder application pain compared to placebo (*P*<0.05), but did not reduce sampling attempts. At present, this spray cannot be recommended for arterial puncture anesthesia, and further study on different timing is necessary.

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Keywords: Vapocoolant spray; Arterial blood sampling; Randomized clinical trial; Pain

Introduction

Arterial puncture (AP) is the most accurate procedure for measuring blood gasses and acid-base state. It has also been used for angiography and arterial cannulation. It can be learned easily and has very few contraindications, most of them relative. Obviously, AP accompanies pain during the process (1). Traditionally, several anesthetics have been used to reduce pain in order to decrease the patient and physician discomfort, failure rate, and theoretical needle stick risk. These anesthetics are administrated topically (e.g. amethocaine) or through infiltration (e.g. lidocaine). While the application of most topical agents is not feasible in the emergency department (ED) because of the lag between application and analgesia, lidocaine is considered useful (2). This usefulness is not without problem; although lidocaine infiltration has been recommended (3,4), physicians do not commonly use it because of their belief in infiltration pain, increased procedure time, and puncture site distortion (5). Thus, a perfect anesthetic needs to be effective, noninvasive, and have an immediate onset of action in order to be practical in ED.

Topical vapocoolant sprays can produce immediate skin anesthesia. They were first used with this mean in 1955 (6). Commonly used vapocoolants (also known as cryoanalgesic) include ethyl chloride, fluorohydrocarbon (such as dichlorotetrafluoroethane (Frigiderm) which was discontinued in 1997 due to concerns about damage to the ozone layer), and alkane mixtures (butane, propane, and pentane) (7). They have different utilities

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such as for sport related injuries, minor surgical procedures, chronic dermatologic conditions (8,9). A drop in temperature by rapid evaporation of the volatile liquid sprayed on the skin surface causes brief interruption of pain sensation, possibly through desensitization of pain receptors or activation of ion channels involved in pain transmission (10).

Previous studies of vapocoolant sprays for reducing pain were mainly on venipuncture with inconsistent results. There was only one prospective open-labeled controlled study on AP for arterial blood gas (ABG) sampling with ethyl chloride which did not show effectiveness.

We assessed the efficacy of a topical alkane vapocoolant spray for decreasing the pain of AP.

Materials and Methods

Study design

The study was conducted between June 2010 and January 2011 in the Imam-Khomeini Hospital, Tehran, Iran with the approval of local research ethics committee and informed consent from the patients.

An experienced 2nd year ED resident performed all AP for ABG sampling procedures and pain scoring in order to ensure procedure accuracy. All scores were recorded separately. The patient was asked to score the spray and procedure pain using a numerical rating scale (NRS).

Treatment assignment was done by block envelope randomization, choosing the spray type according to the number in the envelope. After choosing the spray type for the patient, the ED attending physician applied either vapocoolant spray from a distance of 20 cm (group A) or water spray to the site of AP with the same method (group B). The resident, who was not present during spray application and was unaware of spray type, was asked to perform the procedure in less than 1 minute after spray application.

Patient selection

Eighty-four patients were selected who needed ABG sampling and also were alert and cooperative. Patients were excluded if they met any of the following criteria: (a) history of analgesic medication used within 24 hours of enrollment, (b) any sign of decreased consciousness, (c) history of skin hypersensitivity, (d) inability to report a pain score, (e) history of a known neurological problem that changes pain perception, (f) history of cold-related reactions (e.g. Raynaud's phenomenon, cold urticaria), (g) abnormal Allen's test. Four patients were excluded because of analgesic usage and because of not signing inform consent.

Material

Standardized 23-gauge needles were used for sampling in both groups. The alkane vapocoolant spray contains propane, butane, and pentane blend, with an added fragrance. The spray was nontoxic and ozone-friendly. The water spray can be in the same size and was covered with vapocoolant spray.

Measures

Pain after the ABG sampling was recorded according to the NRS scoring method, where scores range from 0 to 10. The 0 end of the scale was represented as no pain and the 10 end of the scale as worst imaginable pain. The patient stated pain intensity experienced during the procedure for ABG sampling and spray application separately. The resident reported the number of attempts (defined as completely removing the needle out of skin) at ABG sampling.

Method

In this randomized placebo controlled trial, eighty patients were enrolled and screened for participation and evenly distributed in the 2 groups (Figure 1): group A, patients who received alkane vapocoolant, and group B (control group), patients who had water spray applied. The procedure is designed for taking the ABG sample in less than 2 minutes. The study agent was sprayed onto the skin from a distance of 20 cm before the resident who performed arterial puncture was present in the room by the ED attending physician. After 5 seconds, the site was wiped and prepared for puncture. The ABG sampling was attempted in less than 1 minute after spraying initiation. All the sampling was performed by a second-year resident who was fully trained and had previous experience. The patient's puncture and spraying pain score were recorded after the ABG sampling. The researcher chose the patient's group randomly according to block envelope and applied vapocoolant spray to group A and water spray in group B without the resident's or patient's knowledge. Because spray application was not in the presence of resident and covering both sprays, neither the residents nor the patients knew which kind of intervention had been performed.

Statistical analysis

The mean pain elicited by puncture after vapocoolant and placebo application was 1.2 and 3.6 respectively.

With the power of 0.8 and α of 0.05, each group needed 3 persons for enrollment. Our study was conservatively enrolled, 84 patients.

One unit of difference in the NRS score was considered clinically relevant and statistically significant. The 2 groups were compared on continuous variables with the Mann-Whitney U test or an independent-samples *t*-test. For categorical variables, Fisher exact test was used. $P<0.05$ was considered statistically significant.

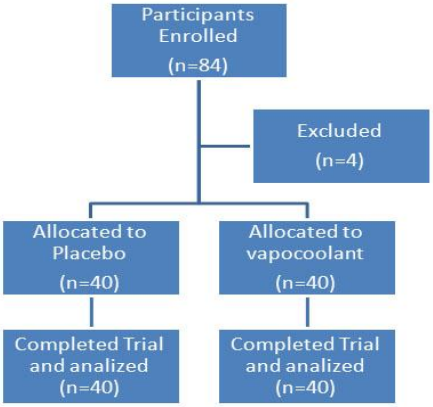

Figure 1. Participants flow chart.

Results

All the patients were selected from the emergency department patients in aforementioned period. All the patients who entered completed the study and all the arterial punctures were successfully performed. There was no significant difference between the mean ages and sex ration in groups A and B (Table 1). NRS score during ABG sampling was also statistically non-different in the two groups (4.78±1.761 vs. 4.90±1.837; *P*:0.945). While the spray application pain difference was significant (1.55±1.319 vs. 0±0; *P*:0), the number of attempts required for ABG sampling was not significantly lower in group A compared with group B (1.38±0.54 vs. 1.53±0.68; *P*=0.372 Table 2).

As an incidental finding, some patients mentioned more numbness after few minutes after vapocoolant spray application.

Table 1. Characteristics of the study population in the group using vapocoolant and the group using placebo

Variable	Using vapocoolant (n=40)	Using placebo (water)(n=40)	*p*
Age (year) mean, (range)	56.5 (20-76)	48.5 (19-75)	0.209
Male sex %	55	47.5	0.327

Table 2. Comparing pain and number of attempts in the group using vapocoolant and the group using placebo method

Variable	Using vapocoolant (n=40)	Using placebo (water)(n=40)	*p*
AP pain mean±SD	4.78±1.761	4.90±1.837	0.945
Spray application pain±SD	1.55±1.319	0±0	0
Number of tries±SD	1.38±0.54	1.53±0.68	0.372

Discussion

This is the first randomized controlled trial analyzing the use of cryoanalgesic before ABG; however, studies on other procedures such as intravenous cannulation have reported conflicting results for controlling pain in comparison to other modalities and placebo (7-9,11-18). Our study showed that using the vapocoolant spray before ABG sampling exerts a little more pain and does not reduce pain remarkably. It also did not show that use of these agents would reduce the average number of unsuccessful attempts at sampling.

ABG sampling can be very painful for the patient, especially when the procedure must be repeated due to

indication or failure (19). Furthermore, the patient's pain makes the practitioner uncomfortable while performing the procedure. Therefore, the more the patient's pain is alleviated, the more likely ABG sampling would be successful. There are several kinds of literature about different agents for this mean.

Despite the fact that lidocaine can cause vasodilation and more bleeding, some authors have recommended using a subcutaneous infiltration of lidocaine before arterial puncture (5,19). But this practice is not followed very much (for example in only 2% of the ward doctors in a part of England) (19) and would also be lower in crowded emergency departments with less time. The jet injector as another method of application has been shown to be effective but still needs to be studied further (20). Local anesthetic application such as lidocaine creams is another method that can be used before unpleasant procedures (21). However, different studies showed that the cream (tetracaine gel, 4% amethocaine gel, EMLA) is not useful in reducing pain during arterial sampling (22-24). EMLA is also expensive and can take 30 minutes or more to take effect which is a major limitation in a busy ED needing swift diagnosis and treatment (16,30). As another option, vapocoolant spray has many advantages such as easy application, no needle involvement, and rapid action. While the old types were flammable, this problem has been addressed in new alkane forms.

Vapocoolant effectiveness and other aspects of the application (e.g. vein visibility, application pain) have been studied extensively in both pediatrics and adult population for venopuncture. Hijazi *et al*., (2009) performed a randomized controlled trial in adult patients and claimed that its usage was associated with significant pain reduction but no decrease in number of cannulation attempts. They also state that the pain of spray application was significantly higher with vapocoolant in comparison to placebo (7). In another study on pediatric venopuncture, the researchers stated that vapocoolant decreases the number of attempts in addition to reducing the pain of venipuncture (15). This spray has also been studied in dialysis patients who experience 300 punctures per year to their arteriovenous fistula. Pain reduction has been shown with both vapocoolant and EMLA (25). There is only one open labeled, nonrandomized trial on vapocoolant in AP which did not show any effect (2).

Other aspects of the application such as duration, distance, and the difference in application-sampling lag before ABG should be studied as well. The attitude of patients and doctors towards analgesia and ABG sampling was not assessed here, and further investigation in this area is also required. In addition, it has to be studied in pediatrics population.

As a limitation, having all the sampling done by one person, although prevents variability in technique and compliance with study protocol, may amplify operator bias. In addition, this was a single center study and blinding was not verified.

To the best of our knowledge, this is the first double blind randomized controlled study performed on vapocoolant spray efficacy on AP pain reduction. The study demonstrates that application of a vapocoolant spray prior to arterial puncture is slightly painful and does not reduce the pain of arterial puncture when compared to a saline spray. It also did not reduce the number of attempts prior to successful arterial puncture. This might be due to the deeper location of artery in comparison to the vein which leads to more nociceptor activation during puncture. As mentioned above, increasing the interval between the spraying and puncture may increase the effectiveness. These results suggest that a vapocoolant spray should generally not be used prior to arterial puncture in the ED. The vapocoolants application need to be studied more (e.g. studying more application puncture lag time) in AP before any further recommendations.

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